Edgar Serna M.

Virtual Teaching-learning Environment

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Editorial
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PREFACE

I am convinced that learning is for life and that for children: 1) let them live, so that they can understand the universe, 2) to form them as persons so that they find their place in the universe, and 3) to train them as professionals so that they understand and intervene into the universe.

Edgar Serna M.

When the researcher and his team attempt to work in a relatively new and rapidly evolving area of research, they resort to studying and exploring the foundations on which that area originated, especially by studying its founders and pioneers to create a broader vision and achieve a better understanding of it. In this way, researchers understand where they are and why they use certain methods and methodologies because they have studied and analyzed what came before. Accordingly, and in line with the content presented in this book, in the golden age of Artificial Intelligence, and after great efforts focused on studying natural intelligence, important discoveries were made about the teaching-learning process. In the 1950s, it was understood that the human capacity to learn was a crucial issue that should be analyzed accurately and comprehensively, and at the same time fully understood.

Although the aim of this book is not to analyze in detail each of these contributions, a tour through them is presented with the idea of introducing the reader to the content. From the beginning, and when the existence of many different types and forms of learning was identified, researchers realized that it was indeed a complex field. When a team considered that they had solved a particular problem and structured a consistent model, a new one would appear almost immediately. This has meant that, so far, some have been successfully investigated, but many remain to be explored.

They also found that learning was rigorously linked to other, equally complex aspects of natural intelligence, such as reasoning, perception, knowledge representation, expression in natural language, concept abstraction, analogy recognition, and many more. Furthermore, they found that learning was solidly connected to teaching, so they concluded that, if coherent models of learning are available, they should be relevant to the design of teaching support systems. Since then, and to this day, links and interconnections between these aspects continue to be discovered, and may not end.

In this order of ideas, today we know that, although the generation and comprehension of natural language are interconnected and are immersed in the domain of language processing, they are not the same. The point is that a sender can create a well-structured sentence, but no one may listen to it, or the receiver may not understand its meaning. This happens because there is a common communication problem between the sender and the receiver, which is also observed in the comprehension of written text, caused in part by the differences they have, both perceptually and culturally.

But in electronic communication things are different, because functions, channels, deadlines, and spaces are constantly changing due to technological developments. In this context, the senders not only speak but can check whether the meaning of the speech is transferred properly. Similarly, electronic receivers are different from physical receivers, so teachers and students differ profoundly from their *real-world* counterparts because they are part of a completely different

context of interaction: the *virtual world*. Based on this knowledge, the behavioral observations that are experienced daily in the real world, amid a world interconnected by electronic communication technologies, are extended and exploited in the electronic teaching-learning processes.

On the other hand, in this century the knowledge generated by technological developments is growing rapidly, as never before in history. This increases the complexity of learning options, modes, and models, along with the areas of knowledge to be addressed in a teaching-learning process. This situation generates a myriad of variables and fluid situations that make it difficult to fully address and explain what we can think because what we think we know about optimized teaching may not generate optimized learning.

In any case, more attention should be paid to the concept of *optimization* and a clear distinction should be drawn between physical versus virtual teaching and learning. This is because learning is a complex and delicate process, relying on many different capabilities that we do not yet fully understand. On the other hand, virtual learning is also a complex process, since it involves developing or enhancing a wide variety of skills that are mostly multidimensional and transdisciplinary.

Before the advent of the Internet, one of the most revolutionary developments in the history of science and scientific reasoning, educational research explored the many varieties of learning, although some are still undiscovered or not studied in depth. In this century that focus of interest has moved in a different direction, which has changed the very nature of the problems researchers address. This increasingly obvious lack of paradigms to cover the full set of problems related to learning triggered a kind of new scientific revolution in which the Internet, with its provision of unlimited access to the world's information, caused unsolved problems in learning to be neglected, while others that had never been heard of before were discovered and prioritized.

This was the reason why research interests in the area of teaching and learning changed drastically in the first decades of the 21st century, where priorities are different and where researchers try to find answers to the countless concerns of science and integrate discoveries in other areas, to offer them to a community eager for results. But they also have to deal with the problem of the amount of information available, something that has never been experienced before in the history of mankind [1]. Although one might think otherwise, this feature of the network has limited research options, because the overwhelming amount of information that researchers must locate, organize, filter, analyze, and understand overwhelms any initiative.

That era, when researchers decided the type of problems to prioritize and solve, has been replaced by the era of immediacy and the emergence of issues to which they must give priority. Problems that are almost always undefined or have not been identified as priorities in the field of research, but which often arise as a result of a major and usually uncontrolled technological development. In this context, learning has become more of a necessity than a real option, given that the offer is growing in all media, especially oriented toward the virtual world. A trend in which teaching and learning are observed and exploited as merchandise, and in which so-called *education* has become a lucrative business for many.

However, although the technological component has been *integrated into* education, a broader teaching-learning environment persists, albeit enhanced by diversified information resources, where the role of the teacher, as an individual *expert*, is diminished and challenged. What we can observe is that thanks to the exponential growth of available information, the education scenario

has completely changed; although the education system, governments, institutions, and most teachers seem to ignore it.

While there is no denying that the network is an amazing learning resource in terms of access to information and its capacity for dissemination, a rigorous analysis is required to understand the significance of this revolution in education. Therefore, one must carefully differentiate between real-world learning processes and virtual-world processes, because they are two separate learning paths involving radically different attitudes on the part of the actors, leading to different learning outcomes. That is why it is necessary to differentiate between teaching-learning processes in the real world and teaching-learning processes in the virtual world because we are talking about very different issues from those that were dealt with before the advent of the Internet, and which must be analyzed and understood in different scenarios and categories.

Traditional (real-world) education is based on common exchange and synchronous interactions and is tied to personal identities, preferences, and styles. The connections and relationships that emerge between students, between students and teacher, and between teacher, students, and context, significantly impact the success of the teaching-learning process. In this scenario, the personal and affective face-to-face component is evident, but efficiency is low. For its part, virtual education (virtual world) seeks first to be effective, but without moving away from the affective. In many ways, the virtual world can enhance the teaching-learning process because it provides the necessary support just where and when the actors request and needs it. In addition, when responsibly structured, information is packaged into personalized volumes of knowledge that can be easily accessed by the teacher, the student, and the institution itself.

Recall that *personal interaction* and *personalized interaction*, although phonetically and morphologically they seem similar phrases, represent different concepts. In virtual education, a personalized package can be more effective than personal interaction in face-to-face education. Not to mention that it is organized for a defined learning phase, that it requires more solitary behavior, and that the timing and mode of acquisition may differ significantly among learners. In education, there are phases in which acquiring knowledge requires more collaborative effort, where the figure of the teacher is the protagonist, but there are others that demand solitary efforts and privacy in self-control and progressive acquisition of knowledge. That is why it is necessary to respect the educational cycle and determine with judgment and responsibility when and how virtual reality support is needed.

In the virtual education environment, asynchronous interaction platforms make possible the development of electronic conversations that otherwise would not even be conceivable, they are a means of connecting people at a distance and open up new exchange scenarios. Unlike what happens in traditional education with the memorization of knowledge, where it is likely to be easily lost if it is not practiced or there is no access to its seemingly only source, i.e., the teacher, in virtual education it is established as a consequence of virtual experiences. Moreover, it can be recapitulated at any time, because access to the customized package from which it was obtained is online.

This is all well and good, but it should not be forgotten that the availability of knowledge and being well-informed are different issues. In virtual education, the student learns to access certain information easily but runs the risk of remaining isolated from the very process of knowledge acquisition in all its complexity. The crux of the matter is that the personalized knowledge of virtual education is subject to standardization. That is, it is conceived to be adapted to each category of

learners. Therefore, when structuring a personalized course, one must first design a realistic and ideal model of the learner. An issue that is not respected in traditional education, because teachers structure curricula from their perspective and experience, forgetting the actor who will receive them, i.e., the student [2].

While in traditional education learning is conceived in terms of distributed learning, because it is based on a set of different resources and types, in virtual education learning is formulated in terms of ubiquitous learning, because it is thought and developed on platforms available and accessible in many different places and at many different times. On the other hand, research and analysis in virtual education have found wide differences in the acceptance of these new configurations in different cultures. And if students still miss the experience of traditional education, where *content is dictated* to them, virtual education can somehow create the illusion that, if they cannot physically go to an institution, in the virtual environment they have the content at their disposal.

That is why it is necessary to be responsible and present virtual education as a real opportunity, not to generate illusions in students that can easily turn into disappointments. For example, many institutions promote their initiatives in this type of education as a substitute for the full experience of traditional education, although it turns out that for them the virtual learning process is equivalent to a face-to-face one, they are not able to simulate concepts such as attendance, presence or teamwork.

When they spread and reach other cultures, virtual teaching-learning environments can be seen in two different ways: on the one hand, they represent a real opportunity for access to education, which would otherwise not be available; but, on the other hand, they can be perceived as a real shortcut to the degree. They can even be seen as an aggressive and threatening tool since they are interpreted and considered as a means to infiltrate packaged knowledge through forms and principles that the receiving culture does not share (neo-colonialism). That is, they can be interpreted as a standardization of the teaching-learning process experienced in the country of origin, for countries that have not yet decided to promote this type of education in their territory. When considering these environments from this perspective, and although it is true that it is the student who learns, they could be perceived as an infrastructure designed to make individual ways of thinking change, and therefore could be uncontrollable.

They can also be perceived as a real threat to the hierarchical structure of the educational institution. It is not unknown that the fear of replacing people is one of the side effects of the emergence, growth, and capacity of technologies. It follows that concepts such as *ever-changing conditions* and *continuous learning* are presented as challenges or opportunities for each person at any stage of the educational process. The reality is that, whether they agree or not, teachers are obliged to make sense of and master the new technologies and to recognize that in some areas students will have more information and usage capabilities than they do. The teaching institution has to continually re-invent itself and re-design its roles; moreover, whenever teachers feel threatened by new technology, they must find a way to justify their presence in the educational system.

In traditional education, teachers are seen as role models and students identify with them. At the same time, teachers are seen as the sole possessors of information and knowledge and, as a result, they become the mirror through which students want to see themselves. But, with the arrival of technological devices, teachers became more concerned about preserving their identity, role, and work, and their influence and impact on students changed radically. Currently, and very

rarely, they see themselves as true specialists in an area and even have to struggle to keep their knowledge up to date and decide what to consider a priority in the overwhelming volume of information available to them.

This generates an educational dichotomy, because if teachers find it difficult to present what is most up-to-date in their areas, then they opt to continue imparting so-called *conventional knowledge*, and although much of that *old knowledge* helps students to understand where and why we are at this point in history, it is also true that they need to know what is being done in this century around the world. This presents a problem for virtual education, because students seem to prefer, and sometimes even feel compelled, to simply know what is new, unaware of the connections to previous knowledge. In this way the image of virtual education is reduced simply to technology for learning, making much of the previous knowledge seem obsolete. This is the responsibility of those institutions that are only interested in economic welfare, and do not strive to structure environments in which people are formed and trained.

In the way of working of the educational institution, the need to design virtual environments as true educational platforms, in which sufficient integration of information is achieved, must be highlighted. Therefore, one of the main threats to virtual education is the dimensionality with which the platforms that support it are designed; because they are structured based on curricula developed from a particular ideological structure and a specific cultural model, specific and, almost always, unique to a country or region. Thus, for some cultures, especially those for which possessing knowledge is the result of a progressive path of education and training, this new concept of education is nothing more than accelerated, focused, and widely publicized learning.

Another belief that collapses in virtual education is that power and teaching have always been interconnected concepts since there is the power to decide what, when, how, where, to whom, and to what extent to teach. Moreover, people acquire more power as they acquire knowledge because it allows them to better understand the world and adjust it through changes they deem necessary. The harsh reality is that the Internet has become a space where anything is stated with the *voice of an expert*, and people believe it. However, there are also contributions from people who know what they are talking about because they research, demonstrate, and socialize serious results. Much of this *knowledge* comes from the teacher's field of action and memory, which increases the possibility that, when presented to the student, it is already considered obsolete.

Just as the technology of the printing press increased literacy and generated an exchange of ideas that were previously reserved for the few, thereby revolutionizing the way humanity learned and shared knowledge, virtual education has generated a revolution in the 21st century that will change society forever. The reason is that it is designed and implemented in a structured and accountable way and, like the printing press, provides access, choice, and power that until recently was not available to everyone in education. And just as Gutenberg's invention expanded the amount of information available to the world, virtual education is creating a revolution in education and an exponential leap in the development of new capabilities in people.

Virtual education began as a disruptive technology, a kind of innovation that changed the way education is delivered around the world. And as a disruptive innovation that tends to be simpler and more affordable than what already exists, it is becoming a standard for education in the New World Order. Of course, there is still a lot to learn and analyze before accepting the opinion of the visionaries for whom this innovation, which started as an alternative solution to small problems in the education system and then began to handle more complicated problems, will soon take over and replace the traditional way of educating.

The reality is that technology alone is not going to replace the dominant way of conducting the teaching-learning process, although it has shown that it can transform it. Taking the traditional, one-size-fits-all model of teaching and bringing it to an online platform expecting to achieve true learning outcomes would be like taking a steam-powered vehicle and expecting it to meet the social needs of transportation in this century just by adding new tires. This is a short-sighted view of how to harness the benefits of technological developments in education. The process requires an organized, multidimensional, and transdisciplinary structure to design the curriculum, while respecting what students know and their learning model, and has to be seen as a model of education in which people are engaged and participate in the whole process of education and training.

Therefore, the potential of virtual education as a personalized learning approach, in which principles of traditional education are interwoven and complemented to design curricula tailored to the needs and interests of each individual, must be harnessed. This makes it the teaching-learning approach that can best serve the needs of the new category of learners, as individuals with different learning styles, multiple intelligences, self-paced learning, and unique aspirations [3].

Traditional social approaches often attempt to conceptualize technology as opposed to nature or human beings, as a quasi-anonymous power imposed on society and individuals from outside. However, as the sociology of technology has shown, its development can only be understood by its responsiveness, its occupation, and by its use. But it turns out that technology does not determine society; rather, society becomes increasingly dependent on technology as it relies on its use, even though it knows that it is prone to failures and always carries unwanted side effects.

In the 21st century, this is especially true for education, because people are developing a kind of attachment to living their lives, working, and studying in the virtual world. But this tendency to a kind of *social isolation* should not be seen as the basis for structuring a virtual education model, because it would be like trying to cover personalized education with the veil of *impersonalization*. Hence the urgent call to design and structure curricula, teaching models, didactics, and virtual teaching-learning environments with human responsibility. This is the basis of what is presented in this book, which describes the context of these environments as a powerful element to help revolutionize the educational system, but without departing from the responsibility of serving people for what they are, and not as mere sources of income.

This book is a product of the research project: *Intelligent education to innovate the formation and training of the new category of students. Part 1: Programmed Learning*, sponsored by the Instituto Antioqueño de Investigación in Medellín, Colombia, whose results were also used to structure and formulate three undergraduate and two graduate programs. The content is structured as follows:

Chapter I. *The context of virtuality*. One of the structural components of virtual worlds is virtuality, which has rapidly become a way of life in most social activities. This means, for example, that in the 21st century, a large part of society is more familiar with virtual interaction than with real interaction. Of course, it has also changed people's behavior because, in virtual worlds, they share products, make purchases, play games, watch movies, participate in educational programs, and many other things that are becoming less interesting in the real world.

Chapter II. *Virtual education*. In the coming decades, humanity will witness a revolution in education, unlike anything that has happened in this area since the invention of the printing press.

In this century workers want and need to learn things on demand, at any time, and at any moment; young people have greater mobility and access to mobile technologies and therefore want to learn anywhere while on the move. This ubiquity makes people want to acquire the necessary knowledge just before or just when they need it. This is why education must design and implement teaching-learning processes that respond to technological change and the demands of the New World Order.

Chapter III. *Virtual teaching-learning environments*. In these environments, the relationships between curricula, teachers, and students are developed in a distributed and collaborative way, so that the processes of learning and knowledge are not restricted to the knowledge of a single individual. This is in line with the perception of neurocognition, in the sense that cognitive processes are distributed among the mind, artifacts, groups, space, and time. Furthermore, the educational practice has shown that the mental load of learning is spread physically, socially, and symbolically among individuals and the tools they use in their formative process.

Chapter IV. *Tools and technologies for virtual education*. The tools and technologies for virtual education are complex constructions that, in themselves, are considered a body of knowledge and structure of virtual teaching-learning environments, where they are part of the process as well as a product. However, virtual can be an illusory concept, with multiple meanings, so such an environment doesn't need to always involve digital technologies or tools to be considered virtual.

Chapter V. *Appreciations related to virtual education*. Virtual education requires the teacher to choose, adapt and refine, through feedback, verification, and validation of learning outcomes, through reflective activities that maximize the possibilities of technology and neurocognitive discoveries. Therefore, it must design educational experiences centered on learning, knowledge, evaluation, and the student, with high levels of learning for all. As in any type of education, virtual education must harmoniously and structurally integrate the State, administration, teachers, students, society, and the productive sector, because survival in the New Age is a task that we must all achieve. In addition, a series of relative appreciations, such as those described in this chapter, must be observed and respected.

Chapter VI. *Design of virtual teaching-learning environments*. The success of these environments lies largely in their design because one of the situational factors associated with learning in virtual education is centered on the motivational conditions of the students. Therefore, the design, development, implementation, and continuous improvement of the virtual environment must be engaging and motivating. Furthermore, as an Information System, a virtual teaching-learning environment must ensure compatibility between design features and user requirements. Also, the learner is the center of learning, so the design approach must be user-centered, satisfy the user's needs, offer net benefits of use and draw the user's attention to interact, discover knowledge and acquire learning.

Chapter VII. *Intelligent education*. The intelligent education program is an imaginary that is part of a research agenda focused on the developments of neuroscience, neurocomputation, neurocognition, and Computational Sciences, whose objective is to design, structure, and implement intelligent learning algorithms oriented to innovate education in the XXI century. This imaginary starts from a conceptualization of the relationships between learning algorithms, neurocomputing, and new learning spaces for the New Age. The program combines transdisciplinary developments and discoveries that these areas have achieved, with the idea of offering intelligent education based on information processed with algorithmic models.

1. THE CONTEXT OF VIRTUALITY

In the 21st century, the development of new technologies and electronic activities have positioned themselves as agents of educational transformation, although it is possible to trace the genesis of virtual education based on human collaboration, knowledge work, and innovation back to the development of networks in the mid-20th century. In later decades, technological innovations were added that introduced an unprecedented opportunity for people to communicate and collaborate, despite living separately and at different times, which were the key to paradigm shifts in social, economic, and, especially, educational matters. However, the traditional education practiced in most institutions has remained stubbornly resistant to change.

Many of the researchers involved in these experiments were academics, and as they introduced e-mail and computer conferencing into their teaching model, they discovered vast possibilities for improving student communication, interaction, and collaboration. While in the 21st century people, almost, by and large, know and use these developments, for those pioneers the process was not so simple. The technology was unprecedented: what was e-mail? what was computer conferencing? how to use one or the other technology? how to value them? how to design them for education?

The first thing they had to learn, and teach, was to differentiate one from the other, because conferences were more of a group communication system, while mail was a one-to-one or one-to-many mode of communication. Moreover, these developments were occurring in the shadow of social disappointments and criticisms of educational television, so as a new technological application in education, they were met, at best, with skepticism, but with derision most of the time.

Undeterred by the situation, some visionaries saw the potential for their use in education and continued to work on their development. Some focused on e-mail, while others increasingly recognized computer conferencing as a key factor facilitating collaboration and interaction in educational discourse and teamwork. From then on, not always with acceptable results, technologies moved further into aspects of social life, such as education, until they became a kind of starship in the policy fleet of governments around the world.

This emphasis on technology for education has also contributed to the development of initiatives to promote greater capacity and entrepreneurial activity in innovation systems. And today, it is common to observe that technology planning is part of national knowledge foresight and science policy programs, thus promoting the emergence of emerging industries, the transfer of knowledge, and the development of new technologies. That is why it is accepted today, without much opposition, that technology is a key factor in the knowledge economy.

But this technological revolution demanded new forms of literacy because, although it transformed most of the dimensions in which human life develops, work is still being done to solve issues such as so-called learning disabilities. In the 21st century, developments in information and related technologies have transformed the practices of reading and writing, communication, visualization, transmission, storage, and retrieval of information, modifying the social nature of knowledge practices. Although the new technologies bring with them complex ontological, epistemological, ethical, and identity problems, the fact is that they offer interesting educational

or related development possibilities. It is enough to mention that computers have stimulated the development of mental models, collaborating in the progress of neurocognition.

Likewise, and as a further development of Information Technologies, virtual learning environments emerged in the 21st century, which are transforming the teaching-learning processes and, therefore, innovating the world and our understanding of it. But, as a technological environment, they carry systemic and ideological prejudices and assumptions, so society must remain critical and be aware of them, as well as of the contexts in which they are created, supported, and from which they obtain support. In this way, we can develop the capacity to understand the responsibilities of use, creation, contents, prejudices, values, and ideologies of virtual environments.

One of the structural components of these environments is virtuality, which has rapidly become a way of life in most social activities. This means, for example, that in the 21st century, much of society is more familiar with virtual interaction than with real interaction. Of course, it has also changed people's behavior, since in virtual worlds they share products, make purchases, play games, attend movie premieres, participate in educational programs, and many other things that are becoming less interesting in the real world.

Amid this substantial change in the way, people relate to each other and as they collectively educate themselves virtually, it seems that humanity is beginning to reason differently as a species. And while virtuality is not limited by characteristics such as orality and literacy, it is certainly influenced by them; furthermore, while it is true that it is mediated and updated by technology, it is not limited by it either.

The term *virtuality* is related to Aristotle's belief that every entity in the world could be described by its potential, or *dynamism*, and actuality, or *energy* [4]. For Peirce [5] the concept starts from the virtual knowledge of Scotus, for whom the term virtual suggests something that is *as if it were* real. Deleuze [6] suggests that virtuality is associated with *opposing the real*, but opposed to the actual, while the real is opposed to the possible. Whereas Rheinhold [7] uses the term to refer to the *appearance* (of a thing), as opposed to its more concrete *reality*, which may not be important. In any case, the concept of virtuality is not new, and despite having remained for decades as a science fiction prognosis, only until it could be materialized thanks to technological developments and massified, it became a viable technology.

Virtuality is at the top of the cultural tools that humanity has used to capture, transmit and experience its ideas and, for many, it is the most recent proposal in the field of education. Some of these tools can be seen in historical records and range from paintings, narratives, experiences, impressions, and radio and television waves, to immersion. Because of this, and taking advantage of advances in Computer Science, in this century virtuality is a real-time simulation technology, which allows the user to experience immersion in a *reality that is not their natural environment*.

Thanks to these advances, society began to migrate many of its activities to virtual worlds, causing at the same time that the new generations increasingly abandon physical interrelationships, to migrate to immersion in the network. Part of these activities is mediated by technologies such as smartphones, videos, messaging, blogs, social networks, games, online universes, forums, chat channels, ... [8], and, of course, education [3]. A domain then emerges in which communication, collaboration, and work converge in a kind of revolution that aims to transform the network into an increasingly important medium for communication, learning, research, collaboration,

entertainment, and industrial development, and which materializes in a revolutionary context that provides opportunities for technological, commercial, cultural, scientific and educational development that, in a way, can help to improve the quality of life of the Information Society.

One manifestation of these changes can be seen in the fact that the web is migrating from a two-dimensional navigation interface to a three-dimensional one and, in the same way, that Mosaic impacted the different social environments, this passage from a static-bi-dimensional environment to a virtual-three-dimensional one for managing information originates a new and significant revolution [9]. The emerging scenarios make possible, among other things, collaborative work between people from different parts of the world, in 3D environments and different areas. In this century, this revolution is evident in the innovation of different employment patterns, generating worlds in which people participate and contribute without physical presence [10], while virtual economic markets emerge in which real products are traded [11].

The social penetration of this technology allows people to make the most of the information, and to draw and achieve goals that would not have been possible with previous developments [12]. One of the peculiarities of the reception of virtual worlds is that, although computers and software are considered to be cultural products of the real world and, therefore, are subject to the rules and norms of the same, when entering them all that disappears. The reason is that very different rules must be respected there, in most cases established by the users themselves, which generate phenomena hitherto invisible and considered *culturally discontinuous*.

As this revolution progresses, new scenarios become a reality, immersion takes hold as an omnipresent environment, new ways of creating and innovating are generated, business and learning opportunities appear, vehicles for knowledge generation and development are created, and borders, cultures, and distances vanish, giving way to social universes outside the real world. The global world is interconnected through digital technologies and this structure evolves at an accelerated pace, in part because it works *in-direction* and *iteration*, that is, it learns again and again from past successes and failures to achieve new and better products.

In the 21st century, a convergence of four technological initiatives is envisioned towards a singularity that could define the next structure of communication and education, which some have named *immernet* or *immersive internet* [13, 14]. This development will enable the dissemination of information and knowledge to and between inhabitants of virtual worlds, while at the same time generating new commerce strategies, which will require new forms of teaching-learning and interaction.

In any case, the principle of virtuality refers to an aspect of reality that is both ideal and real, therefore, it is the content of a given medium that can exist only in the mind of the author, and that can be shared with others. For example, the world represented by a movie script exists only for the person who wrote it, but when the movie is made, it becomes the real aspect of that virtuality. In addition, when technological developments are used to simulate a series of objects, from a structure that its creator imagines, the result is a virtual world of the same. For Marín [15] it is an anthropological structure that is part of the experience and, therefore, it is not independent of the mind nor can it be reduced to something physical.

For Sherman and Craig [16], virtuality is a medium that presents a wide utility for the exploration and communication of ideas, and as a support for other means of human communication with which it shares properties. For these authors the term *medium*, as something that relates two

things, can mean: 1) carrier, when it transfers matter and energy, and 2) communication when it does so with ideas or concepts. At the boundaries of each, there will always be an access point traditionally known as an *interface*, through which virtual worlds that may be contained in media such as the human brain are accessed. In the real world, the sender communicates contents that allow the receiver to experience the physical part of them through virtuality, i.e., he interprets them in the brain and immediately creates the virtual world in which he can represent them.

That world is a simulated representation of an abstract domain in the mind of the creator, which materializes by respecting rules of behavior (programmed or imagined, simple or complex) that can be automated, for example, in a computer program or through rules in a family game. Because this domain is an extension of the real world, it involves participants, objects, and rules established in the mind of the subject experiencing the immersion. Therefore, an important aspect of virtuality is that the person must have the capacity for wonder and belief in what he or she experiences. In addition, as a medium it allows him to communicate through mechanisms (virtual worlds) that support the transfer of content.

Although this communication exercise seems simple, it is the basis on which much of humanity's progress and culture is based. This inclination to reflect and transmit ideas has accompanied cultures since time immemorial, and technology is the means to achieve this most efficiently. The process begins when the person abstracts the real world and structures communication in a virtual one, which turns it into a tool that offers special characteristics that other media do not possess, such as the manipulation of time and space, interactivity, simultaneity, and dynamism, necessary to achieve the objective of the message.

1.1 REAL WORLDS AND VIRTUAL WORLDS

To define the *real* is to speak of what exists and how it is perceived, while the *virtual* is something imagined or modeled from the real. Philosophically, the real includes that which has existed, exists, or will exist, and the virtual is things that are imaginable, but not real. On the other hand, *real reality* refers to the real world, and *virtual reality* to the modeled world; the former seeks to differentiate the experiences, interactions, and activities typical of the real world from the sensations of the virtual domain. This differentiation is necessary because digital development has extended the dimensions of the material universe, i.e., time, space, and matter [17], the effect of which is seen in innovations that change the material to non-material, increasingly developing digital products and services in companies that occupy virtual spaces, rather than real spaces, with processes that are not performed in time but in *non-time*. After all, they are not executed in a linear sequence of real events, but in programmed autonomous events.

The opportunities, interactions, and communications in both realities imply that society is moving from the reality of time, space, and matter to the virtuality of no time, no space, and no matter [18]. But, although these new dimensions are located outside of any time and place in the real world, the consensus is that, for the moment, the most rewarding experiences are those located in real reality. So, finding an answer to what is *reality* is not easy, because to accept that it is everything that is perceived through the senses would be to ignore entities that cannot be perceived but are real.

For Westerhoff [19] reality is everything that, although it is not thought, believed, or felt, does not disappear; but this definition does not consider real objects such as stock exchanges, which, if one stops believing in them, would cease to exist. On the other hand, some try to define reality in different ways: 1) by comparing it with a planet without human beings, in which everything that

would be real with them is not real, such as countries, wars, languages, ... [20], or 2) by confronting it with fundamentalisms, i.e., that it is constituted by all the fundamental things that, to exist, do not depend on others [21]. This definition is more restrictive than that of the world without humans because realities such as a mountain would not be a reality, since their existence depends on other things.

From the scientific point of view, it is possible to define real reality only in terms of matter and energy, that is, in an optic in which anything is real. From this practicality science needs few arguments to explain reality: particles, forces, quantum mechanics, etc., and although it seems a consistent definition for real reality, it is still somewhat insubstantial, because even the most solid matter is constituted of atoms made up of sub-atomic particles and electrons. This means that this matter is mostly empty spaces because among its components there is nothing at all. According to physics, what makes matter real, with shape and volume, are the electrons that give it shape: electrons, quarks, and gluons that constitute most of the real things [22]. But when matter and dark energy are included, this standard model loses clarity, because together they make up about 96% of the real universe.

On the other hand, when CERN scientists observed traces of something that appeared to be a particle, predicted by mathematics more than half a century ago, a definition emerged in which real objects might not be made up of particles or strings, but of numbers, because mathematics is real [20]. The issue here is to find out what mathematics is made of, because if its structures are derived from the empty set, i.e., nothingness, then all reality reduces to *nothingness* [23]. Moreover, mathematical structures do not need an explanation, because they are located in a universe made of nothing and, therefore, for an object to be real it must not have existed in space-time. That is, mathematics does not require a physical origin, because it can neither be created nor destroyed.

A more radical definition holds that, no matter what one accepts for real reality, it is probably wrong, because this universe is a machine and it is possible to explain everything in it in terms of information processing [24]. If one conceptually thinks of a computer as a machine that processes information, and if this concept is combined with the fact that quantum physics is almost couched in terms of information processing, then it is not wrong to conclude that such processing is the root of everything [25]. This assessment may not be so far off the mark, because every process in the universe boils down to interactions between particles by a toss of binary digits, resulting in a continuous interaction of their atoms: *reality.* A striking feature of this definition is that it may shed light on the question of whether something other than nothingness exists, which would indicate that this universe really could have arisen spontaneously. Any attempt to delve deeper into these definitions will generate difficulties and conflicting positions, so that leaning towards any one of them may result in a departure from reality itself.

Then virtual reality emerged as a technological concept in which it is possible to find more common ideas, which takes many of these approaches to structure a definition of reality, which is based on the conception that this universe is fundamentally composed of information. This concept is supported by discoveries such as that space-time is *pixelated* [26], so it would be a holographic representation where 3D reality is a projection of information encoded on the two-dimensional surface of the boundary of this universe. On the other hand, according to Hegel, the essence of technology appears only in concrete and particular technologies that, necessarily, embody the essence of technology [27]. In other words, every element of the real world is created with the help of technology, so people are technological products since the only way to create them is through technology.

Therefore, it is not strange that definitions of virtual reality are presented in technological terms, although it is also not strange that a consensus has not yet been reached [28]. First, because the most important characteristic for identifying the virtual is whether or not it has technological components, a definition that does not provide a clear conceptual unit of analysis for it. Secondly, because it has no theoretical dimensions that allow it to vary, i.e., the definition assumes as virtual all systems that include technology and as non-virtual those that do not. But this statement is ambiguous because it does not determine the theoretical criteria that allow comparisons to be made.

Even so, popular definitions always refer to some technological concept, for example, that it is a technology that persuades the user to be in a world different from the real one, because it replaces their sensations with data generated on a computer, with factors such as immersion, interactivity and intensive information [29]. This definition gives the impression that virtuality is a relatively new development. It is linked to computers, which is not true, because in various ways it has been part of the development of cultures. For Sherman and Craig [16], it is a world in which interactive simulations give the user the feeling of being immersed in it because the actions stimulate their senses. It may provide more insight into the essence of the virtual in this way, but first, the term *user* would have to be interpreted, because if it is considered to be a person, then what about avatars? Assuming this interpretation excludes many types of virtuality, it is more suitable for understanding state-of-the-art virtual reality.

Stanovsky [30] states that virtuality is computer-generated interactive simulations that, among other things, can be shared, immersive and global. There are gaps in this definition, because if simulations and interactivity are necessary for virtuality, then how to simulate real reality and how to differentiate that simulation from those generated by other means, furthermore, what makes human-computer interactivity so special? Another definition holds that it is an interactive 3D world, computer-generated and with a personal perspective, which does not require total immersion [31].

Here it is noted that personal perspective is valued more than immersion because the latter is still considered to be under development and could not be a necessary feature. Other authors claim that there can be no clear distinction between the real and virtual worlds because with consciousness they are the same [32]. For these authors before the universe as it is known today there was no conscious mind, and when it appeared it gave it the status of real. But some detractors consider that one should not speak of something that is not yet clearly defined: *consciousness*.

In any case, the purpose of this book is not to elucidate these definitions nor to go into explanations that are not relevant, but they are included here to give the reader an idea that it is not easy to define what is real and what is virtual. The following is a description of some properties of virtuality that are necessary to describe the context of virtual education.

1.2 PROPERTIES OF VIRTUALITY

Bearing in mind that virtual education is a type of education in which technology plays a leading role, the design of the virtual teaching-learning environment in which the learning processes are developed must take into account a series of properties of virtuality that, on many occasions, are not possible in the real world. Although they are important and necessary to design an efficient and effective educational environment, care must be taken when using them, because their advantages in achieving learning results may not be taken advantage of.

1.2.1 Modeling and simulation

Models represent the construction and operation of a system and, although it is a simpler abstraction, its purpose is to approach the prediction of effects due to changes or interventions. Therefore, it should be a representation as close as possible to the real world, but not so complex as to make it impossible to understand, i.e., it should offer a balance between realism and simplicity. In any case, the representations need validation processes known as *simulations*, in which known inputs are used to obtain outputs, which are then compared with the expected outputs in the real system.

All this is necessary because people must solve complicated and complex problems, which they cannot construct directly without first knowing their approximate behavior [33], so they simplify the problem into simpler parts in such a way that, after understanding each one, they will be able to understand the system as a whole.

As an independent property and when properly understood and used, a simulation is a powerful tool in many real-world contexts. It is a process in which a model of a domain is designed and then simulated using a means to conduct experiments, to analyze the virtual behavior of the system before materializing it and putting it into operation in the real world. The model represents the system itself, while the simulation represents its operation over time, looking for the eventual real effects of alternative conditions on the operation of the model to select courses of action. Another objective of the simulation is to control the system, since it may not be feasible to acquire it due to cost, hazards, time, or simply because it does not exist.

The success of the simulation lies in the reliability of the data and information collected to build the model, as well as in the validity of the characteristics and behaviors because they determine its credibility. In the industry, the best way to verify and validate the models is continuously studied, because the decision-making process to materialize them in the real world depends on it; therefore, the procedures and protocols must be oriented to satisfy expectations as close as possible to the expected performance. Simulation is a tool to evaluate the performance of a system, real or abstract, under different configurations and scenarios during various periods.

1.2.2 Interactivity

Although it is a concept for which there is still no widely accepted definition in the literature, many of them are related to the measurement of specific dimensions, and some authors agree on certain operational properties, for example, as a descriptive characteristic of the new media or as feedback, because the actors participate in message transactions. In either case, that communication flow must be linear or nonlinear [34]. On the other hand, debate persists in the community about how to conceptualize or operationalize the term, although it is accepted that it has to do with the ability of a system to facilitate interpersonal communication.

In all the discrepancies around a definition for interactivity, it is possible to find some common basic properties: it should be categorized as a relational variable; it resides in the minds of the actors as perceptions; it is manifested in the form, content, and structure of the technology; it is evident in the context of human-machine or human-human communication through machines; it involves social presence, transparency, and ease of use; and it requires feedback, speed, and flexibility over time. In analyzing this scenario, Kiousis [35] proposes a definition in which he assumes that it is the degree to which technology creates environments where actors communicate, synchronously or asynchronously, and interact through a medium.

To this we should add other key concepts that help determine the level of interactivity achieved by the actors in the communication: 1) proximity, related to the sensation of closeness they perceive regardless of the distance that separates them, 2) sensory activation, operationalized through the use of the senses, 3) speed, perceived as the time lapses necessary to materialize the communication, and 4) operability of the telepresence, related to the perceived credibility of the system. The levels of interactivity vary according to the technology of the system, the configuration of the communication, and the perception of the actors.

For his part, Yacci [36] proposes additional attributes: 1) it is a cycle of messages that occurs between senders and receivers, 2) it occurs from the point of view of the receiver who achieves the objective when a cycle of messages is completed, 3) its objectives are to communicate and learn, which will be achieved in that order by the sender and the receiver, and 4) it contains coherent messages because otherwise, the communication will not achieve its objective. Liu and Shrum [37] state that interactivity is the level of communication achieved by the actors through a communication medium, combined with the degree to which the message influences them. In addition, these authors add the concept of dimensionality (Figure 1), which in the process materializes from 1) active control, characterized by the voluntariness and instrumentalization provided by the actors, 2) two-way communication, a necessary skill for reciprocal communication, and 3) synchronization because a lag in the process does not allow effective communication.

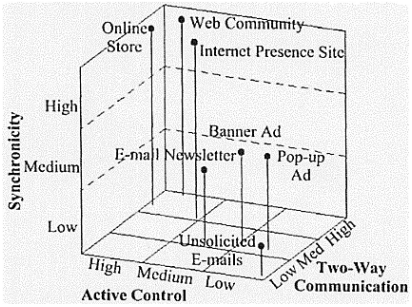

Figure 1. Three-dimensional concept of interactivity [37]

1.2.3 Immersion

This property refers to a state of the *self* in which the consciousness is interpenetrated in the virtual absorbing environment, which represents the simulation of the real *other.* In other words, it refers to an action in which the sensations of the real world are eliminated and replaced by their corresponding ones in the virtual world, taking advantage of the nature of the human senses to perceive in different ways the interactions in that context.

To take advantage of the characteristics of the senses the interface of the virtual world must be wide, surrounding, vivid, and coincidental because the ultimate goal of immersion is to generate a feeling of presence in the virtual world. This notion is a combination of technological (immersion) and cognitive (perception) aspects that define a situation in which the brain and senses are directed to accept the virtual presence as real [38].

That is why some authors describe it as a participatory activity, in which the brain is involved in the story until it disappears from reality and concretizes its presence in virtual reality [39]. From another perspective, it is accepted as a metaphorical term derived from the physical experience of being immersed in water, although one of the most important aspects of immersion is that it must replace the entire context, not just some components because otherwise, the brain would not achieve the sensation of presence in the virtual world.

According to Gander [40], increasing sensory perception does not increase immersion, i.e., a video story does not produce more immersion than a text story. On the other hand, the level of participation of the actor does not increase the level of immersion either, because, for example, if he participates actively he will not experience more than if he participates passively. For this author, immersion is the same in any scenario, what changes is the capacity of the senses to take the brain away from the real world and involve it in the virtual one, because for him immersion is a *mental absorption*.

In the field of virtuality, immersion is usually defined in terms of the technological dimensions involved and the level of interactivity applied, so it would be a technology-based characteristic. Gander [40] describes the elements that an immersive experience should include: 1) *attention*: directed to the source (text, voice, images, sound); 2) *mental construction*: of the world, the plot, the temporal and causal connections between events, and other elements; and 3) *emotional state*: as a response to the content of the story. To these elements, we should add *active perception*, from the point of view of predisposing the senses to perceive the virtual world.

For González [41] immersion is a psychological process that the person enters when concentrating on the virtual world, but the process is complex and, so far, little studied. The author proposes three factors necessary to achieve effective immersion: 1) *willingness to believe*: to accept the virtual world with the awareness that it is unreal; 2) *empathy*: to understand the feelings that are shared in the virtual world; and 3) *familiarity*: because the more the virtual world is known, the less concentration is required.

From the psychological point of view, the *mental state* factor should be added, because there is a risk of not being able (or not wanting) to leave the virtual world. In addition, there must be a trade-off between all of them, because if the person has a greater tendency towards any one of them, then he or she will not achieve true immersion and, therefore, would not effectively enter the virtual world.

1.2.4 Sensoriality

In general terms, this property is closely related to immersion, because the greater the number of senses stimulated, the greater the degree of immersion. By combining the effects of both properties in the virtual world, the person achieves a disconnection from the real world, so he/she stops perceiving the environment and his/her senses tell the brain that now his/her world is the one presented by virtuality. As a discipline, the purpose of sensoriality is to study and evaluate the normal and modified functions of the senses and feelings. This is useful because people live with diverse realities and need the senses to differentiate stimuli and capture the necessary emotions. Although it could be assured that everything that is felt should lead to correct reasoning, most of the mistakes originate from mistaken perceptions.

As an area of research, sensoriality has had little attention and for a long time, it was considered as an inheritance of the body-mind/senses-intellect dichotomy, or a lower order cognition. It took years before the senses were accepted as open doors to the real world and reality because they are a means of communication with the environment and their perception is the basis for constructing the world around each person [42].

The point is that what is perceived does not enter directly into what is learned, although it generates an automatic response from the brain indicating at the same time the type of learning

that is achieved. Based on this conception, virtuality uses sensoriality to *deceive* the brain by telling it to accept as real what it perceives as virtual through the senses.

Sensoriality is a characteristic that is captured by the senses through a receptive field that generates different types of stimuli, depending on the sense that the person uses, so it is also called sensory receptivity. In this way, virtuality adapts to the culture of the individual who is immersed in the virtual world, so culture and cultural stratum are necessary characteristics to achieve an effective sensory experience.

For example, the sensoriality of the virtual world is not the same for an African as for a European, because the senses of each one have different priorities and each one develops some senses more than others. If this aspect is not taken into account in the design and development of the virtual world, it is possible that the virtual world will not reach the same level of effectiveness for both individuals.

1.2.5 Multidimensionality

The real world is defined only through dimensions, so it is described in terms of height, length, and width, as characteristics to which the brain has become accustomed since mankind developed the senses. Hence, multidimensionality is necessary in virtuality, because the virtual world must accurately reflect the real dimensions for the brain to assimilate its physical stay within something non-physical. According to Serna and Serna [43], a dimension can be defined as an aspect or facet of something in terms of: 1) characteristics, circumstances, or phases, 2) area, volume, or length, 3) symbolisms for space and size, 4) a physical magnitude, or 5) a technique for creating depth of visual information.

In virtuality, multidimensionality is closely linked to the latter and different techniques have been developed that allow, on the one hand, to create of content from polygons or stereoscopic to direct the brain to perceive them in several dimensions; in any case, virtual worlds must present a context close to reality, because otherwise, the brain would perceive them only in two dimensions. In addition, sensations for the other senses must be added, because the real world is perceived from all of them. Based on this need, techniques and technologies such as 3D, surround sound and others have been developed to make the message to be communicated more real.

For Morin [44], multidimensionality allows a total understanding of the world, real or virtual, because it helps to disentangle the context in which the message communicated by the sender is confused. Therefore, in this century and with the emergence of interactive and multidimensional events and objects with random components, people have had to develop a strategy of thinking that is neither simplistic nor totalizing, but rather reflective to coexist with these objects, whether real or virtual. In this process, people must build a relationship with all that this fabric implies to develop a univocal definition of the world and assimilate the message it transmits or receives.

In the quest to understand human behavior through interaction and information exchange, some researchers work with psychological or social approaches, while others are convinced that another vision is needed [45] because the complexity of this interaction in the real world must be involved.

This is where the principle of multidimensionality appears, because to virtually represent the real world a one-dimensional approach is not enough, and because the better the understanding and analysis of the immersed complexity, the more realism can be added to the design of the virtual world. Figure 2 describes the principle of multidimensionality according to Fidel et al [46].

Figure 2. Interpretation of multidimensionality in virtuality [46]

1.2.6 Dynamism

Figure 3 describes the dynamism that is achieved in a virtual world from the activity theory, where it is possible to describe actions in the system through a series of interrelationships between the actor and the environment.

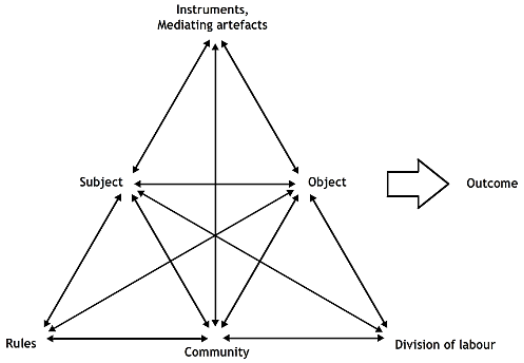

Figure 3. Dynamic interaction activity system [48]

According to dictionary definitions, we could say that dynamics is a branch of physics that studies movement about the causes that generate it, that is, it is the set of forces that act with a specific purpose. But this meaning would lose meaning in the sentence: *John is a dynamic person* because here it would be understood as a quality that allows John to be in constant transformation. On the other hand, in virtuality, dynamics is assumed as the capacity of transformation and adaptation that the elements of the virtual world have, in such a way that the user can experience a higher level of reality, about what he would obtain in a static virtual world.

This property gives the virtual world a high degree of realism so that the brain can grasp it as very close to reality. In addition, because in the real world, most of the elements are dynamic, it is also necessary to achieve an approach to the staticity and the amount of dynamism that is imbued to the virtual elements, because not everything moves and, when it does, it does not carry the same rhythm as the others. So, dynamism is an important principle in virtuality that adds a level of reality to bring the brain into a simulated reality.

In philosophy, it is conceived as a theory according to which the phenomena of matter or mind are developed by the effects of the action of various forces, rather than because of the movement of matter. The basis of this theory is the understanding that matter is made up of simple and indivisible units, substances, or forces, in addition to involving the theory of activity as a concept of interaction between them. This theory considers the context (virtual world) as a dynamic system of work/activity in which the complexity of media, histories, cultures, artifacts, and motivations of

activity in the real world is represented [47]. The unit of interaction in this virtual system is human activity, which involves objects collectively through a goal.

From this point of view, it is possible to understand and analyze virtuality to find patterns, make inferences and describe phenomena, because, in the virtual world, every activity is an interaction that has a purpose that is achieved using tools. By transforming their internal and external cognitive processes used in the interaction, these tools externalize the mental constructs of the author and the actor in the virtual world.

1.2.7 Multimediality

Multimediality has evolved along with Information Technologies in scenarios such as education, advertising, communication, and cinema, among others, which has made it possible to understand multimediality not only as a technology but also as a scope. One definition states that it is the interconnection of several of the functions provided by the media to achieve the objective of communicating. This is evident in each of the scenarios presented, for example, through combinations of text, images, sound, and video that can imitate reality. In the case of virtuality, the construction of worlds is based on the digitalization of numerical data [49], mediated by technological tools that allow their production, storage, and retrieval.

One of the most important characteristics of multimediality is the recurrent way in which it uses media in digitalization. In a virtual world, it is possible to find a miscellany in which they coexist in harmony, regardless of their origin or objective in the system, and at the same time, they help the designer in the sense of offering him diverse combinations for each world he structures. In this new world, transmitters and receivers coexist harmoniously, while exchanging roles or creating new ones. This is because virtuality does not occupy a specific material space, so it is possible to play any role desired without the limitations of the media in the real world.

Another characteristic is convergence, or the possibility of finding in the same space a series of media that are used to shape the virtual world, with the advantage of not having to build them every time they are needed due to their immateriality, and of manipulating them to narrate or represent other stories, in such a way that they come closer to the reality sought by the user.

In addition, multimedia needs a narrative that involves all the necessary means to virtualize the real world to be represented. This characteristic refers to the need to convince the brain of the immersion in reality by harmonizing the media, the message, and the digitalization of that world. What is complicated in this case is that the real world is multimedia, because people live in scenarios in which sounds, images, movements, texts, and other people converge, building the real reality on which people develop their activities. That is why virtuality should take them away from that reality and bring them to a new world, where they can have, in a certain way, better control over the objects in the scenario they inhabit.

1.2.8 Multiplicity

In the various domains in which multiplicity has ascendancy, a common relation of its meaning is found, around the quality of manifold or multitude. For example, in mathematics, it is a class of objects in which any of its members is completely specified using ordered numbers, which represent the properties of that element. In philosophy two types of multiplicity are distinguished: 1) the continuous ones, and 2) the discrete ones, to which a series of characteristics are assigned to find their distinction. The first is qualitative, virtual, continuous, and simultaneous, while the

others are quantitative, real, discontinuous, and successive. In the domain of Computer Science programming, multiplicity refers to the number of instances that a class has about another: one-to-one, one-to-many, many-to-many o many to one.

As a property of virtuality, multiplicity relates to presence and space in the virtual world. In them the duration of progressions and multidimensional interrelationships over the created space occur from multiple points and through multiple media, all mediated by a geometric idea. These relationships between objects and their durations in space are materialized in degrees of immersion, which indicate to the brain the direction in which the virtual world turns and, therefore, where each scenario is constructed and deconstructed. This property makes the user understand the space, duration, and nature of each multiple elements as virtual complements.

But virtual multiplicity must be differentiated from real multiplicity, in the sense that the former is framed in a specific duration in the virtual scenario, while the latter is a plurality of times corresponding to each line of action, which the user executes in a natural scenario. In the former, the duration of the multiplicity is controlled by the immersion objective, while in the latter, given the nature of reality, it is not possible to do so.

In this same sense, it is necessary to differentiate between the logical multiplicity, which characterizes the user's expectation of the virtual world and which is materialized in it through the geometry of the visual and Euclidean spaces, and the logical multiplicity of the phenomena observed and felt. In this way, a combination is achieved between the characterization of forms and the diversification of contents, to respond to the actor's objective within the virtual world, that is, disconnection from real reality is offered to live the virtual reality. Furthermore, by losing its static condition, the multiplicity achieves that the user reaches a visualization of dimensions and not of correlations of the new world so that its expression and position are no longer surprising because the brain is convinced of inhabiting multiple scenarios.

This experience in a Visual-Euclidean space, with a high degree of virtual reality, removes the measurement factor as a component of immersion, because the uncertainty of not being able to differentiate the virtual from the real is simply an extension of what multiplicity achieves in the brain. Each visual contemplation becomes an objective dimension, which forces the sensory system to stay within a system of coordinates, at the risk of leaving virtuality.

1.2.9 Flexibility

According to the context in which it resides, flexibility has different meanings, but in virtuality, it is assumed as the capacity of the elements of an environment to easily adapt to the needs of the design, the objective, and the level of immersion that is to be recreated. The variability of these components must be taken into account, so flexibility must be dynamic, as well as adaptive, yet controllable in the sense of not losing sight of the goal of the virtual world. Psychological and personality issues of the user must also be involved because their reflection will make the avatar adaptable or not to the structure of the virtual environment. This fact decreases the level of flexibility to inhabit that world, while affecting properties such as immersion and multidimensionality, among others.

According to the taxonomy that Schonenberg and colleagues [50] propose for flexibility, the following adaptation in virtuality is determined: 1) *of design*, or ability to incorporate alternative scenarios according to the user's predisposition and emotion response options, i.e., anything is possible, as long as it is not forbidden; 2) *of path*, or ability to change an established route without

altering the goal of the virtual world, as long as the user has authorization to do so, or an exception in the context leads him to take a deviation not previously established; 3) *completeness*, or the ability to execute a specification for which there is insufficient information, i.e., the ability to self-complete a given specification, by direct or indirect relation, according to the user's sensitive and emotional responses; 4) *decision making*, or the ability to modify a process at runtime, and which refers to the ability to modify an initial definition to adapt the virtual world to the changes generated by any of the above flexibilities.

In the flexibility of virtuality, the concept of the *homunculus* must also be integrated, because it represents an image of the user in which the relative sensory space of the cerebral cortex is reflected. This flexibility is fundamental in the control of avatars because different degrees of freedom of the real body is required. After all, the homunculus is a map of the body in the brain that takes advantage of the virtual world to represent locomotion through the avatar.

Being a human characteristic in which the brain plays a major role, flexibility will be affected if the user has a cerebrovascular lesion that may change the sense of where his body begins and ends, which would be reflected in the locomotion of his image in the virtual world. So, in designing and structuring a virtual world, care must be taken not to alter the body schema of this type of user through sensory inputs. In many countries this is considered unethical because of the consequences it could have on the brain of someone who, for example, does not have one of their arms.

1.2.10 Immateriality

In real reality objects are intentional, that is, they have a reason for being in every scenario in which they are used or appear, but in virtuality, they have to fulfill a specific role, or not exist at all. This is due to the consumption of technological resources incurred when including scenes, images, or contexts that have no intentionality in the real world. From this arises the concept of immateriality or digitization of objects through technological developments. It is about transforming material information into an abstract concept that only exists outside real reality, but is presented to the user in a context that guides his senses to accept it as tangible. This property, in conjunction with those previously mentioned, marks the passage from traditional theories of perception based on the real, such as aesthetic, permanent, original, material, and true, towards a communication devoid of them, but imitated through technology.

One issue that immateriality pays special attention to is the fact that in the virtual world, it is possible to represent characteristics, principles, qualities, and scenarios that in the real world are implausible, such as mythical animals, alien beings, or spaces in any region of the universe. The care here refers to leaving a window of disbelief so that the brain can disconnect from virtuality without suffering alterations. Moreover, theorizing the body in its virtuality implies accepting it as an interpretation of the material, but more flexible and socially more determined than its counterpart in real reality.

This immaterial embodiment generates mixed feelings in the users, because there they are fictitious heroes, recognized and admired, while in real reality they may live in isolated worlds with problems of recognition and affection. Although this alternative intelligibility allows the body itself to be used as a conceptual tool, it is still the sum of theoretical propositions that create new modes of perception, which in turn structure the user's understanding and, therefore, new experiences of his body that he cannot feel in real reality.

For all these reasons, immateriality is a powerful property of virtuality that can have advantages as well as disadvantages. All material artifacts, real or not, that can be digitized in a virtual world expand people's environment and daily activities, so in today's society, they have become a cultural phenomenon. That is why they acquire meanings and functions and, as part of the real world, affect their events and lives. Immateriality has led to virtual objects being accepted as real in actual reality, because they have similarities with real-life artifacts, although, in the traditional sense, they are devoid of physical properties.

While this statement is true, current technological developments make it possible to model abstract artifacts that, although they have no real reality, often contain components representative of real-life objects, such as physical properties of color, length, and movement, depending on the environment in which they exist. Because of their immaterial nature, they may also contain properties imperceptible in the real world, such as sounds, smells, or expressions. On the other hand, immateriality can give them an exchange value that confers them to the quality of products, in the sense that they can be traded to generate a virtual economy that mimics the real one.

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2. VIRTUAL EDUCATION

At the beginning of Computer Science, several researchers looked for ways to use informatics in the teaching-learning process, and although at that time it was only possible in large computers and the form of typing and text reading, with the increase in the power of machines and the development of software, the way was paved to put this invention at the service of education. Subsequently, the appearance of personal computers allowed companies, schools, and homes to enjoy computing more widely because the machines were no longer restricted only to text and allowed the operation of color graphics and the use of animation and voice.

Gradually, developments such as the *mouse*, touch screens, scanners, and the microphone were added, which provided a better way of entering data into computers. On the other hand, information output also made progress, and color monitors, LCD technology, color printers, and loudspeakers appeared. But one of the most important advances was to move from stand-alone computers to interconnection through networks, making it possible to share data and information. Network technology allowed machines to communicate and share and enhance processing until its development triggered the emergence of the Internet, which today is used by millions of people around the world for all purposes.

Since then, there has been debate about the effectiveness of computers as a basis for developing teaching-learning processes. Research results are still inconclusive: some report considerable improvements in student learning, while others say they found little or no improvement. What most agree on is that the benefits are achieved depending on the way virtual education is designed, and they emphasize that a virtual teaching-learning environment should not be thought, designed, structured, and implemented in the same way as traditional educational environments.

Some go ahead and propose that to facilitate the teaching-learning process, the virtual environment should include the presentation of information, learning orientation, practice, and evaluation. Others assert that information should be presented through verbal, pictorial, or textual representation, and use examples to illustrate the applications of each concept, rule, skill, or procedure. In any case, the objective should be to guide the student through continuous interaction with the environment, in which he/she will be permanently guided while participating in the assessments to correct errors, in addition to offering suggestions and recommendations. In this way, practice sessions are offered to improve students' speed, fluency, and retention.

On the other hand, the teaching-learning environment should be designed to evaluate the knowledge acquired by the student through learning outcomes, and decide the weak areas to be reinforced.

The reality is that technology affects the way we carry out our daily activities in different ways, and in the same way, it helps the development of society. The point is that while technology is changing our lives, it is up to us to decide how to use it and how to make it work in our favor. Moreover, people expect more and more from these developments, so it's not surprising that those expectations carry over into the field of education. It's the same in industry, where employers expect professionals to have developed skills and abilities to take advantage of technology, learn faster, produce more and better products, and network with people around the world to solve problems.

In the coming decades, humanity will witness a revolution in education, unlike anything that has happened in this area since the invention of the printing press. In this century, workers want and need to learn things on demand, anytime, any time; young people have greater mobility and access to mobile technologies and therefore want to learn anywhere while on the move. This ubiquity makes people want to acquire the necessary knowledge *just before* or *just when they* need it. This is why education must design and implement teaching-learning processes that respond to technological change and the demands of the New World Order.

So far, the conventional education system has inserted technology into its processes at a slower pace than industry. The traditional dogma that classroom teaching is the most effective and efficient way to educate is still the most widely accepted principle in the education system and institutions. While most students and families would like to have the luxury of personalized education, if possible with a private teacher, the reality is that in most countries this is only possible for a few special or particularly wealthy students. In the traditional university, a typical course varies from a seminar with 10 or 15 students to a lecture with 100 or more attendees.

On the other hand, traditional education is still centered on the teacher and preserves the belief that he is the one who knows and that, by logic, he is the one who can provide knowledge and training to the student, who does not know, and who, to memorize it, must repeat it in a recitation of some kind. In this system, the validation of knowledge is given almost exclusively in laboratory practices, with the disadvantage that they are separated from the master class.

In many cases, this application is not done in the educational environment but is left to the student to do it on their own, after completing the course, and if they have sufficient interest. To round off the process, the teacher applies the so-called *standardized tests* to measure the memoiristic assimilation of knowledge, without any practical validation in the formulation and development of projects, much less in real industrial environments. The only thing this achieves is that the student strives to pass the test, not to learn for life. Furthermore, it does not seek to recognize learning outcomes as the validation of the educational process.

In contrast, virtual education is based on a student-centered teaching model, in which students must be responsible for their learning, be motivated to study continuously, and be consistent without the structure or requirement to attend physical classes in person. These environments are strengthened in a context in which the budget is decreasing, while the student population is increasing. Thus, the need to serve large groups and diverse individuals has become a global struggle to provide society with equitable access to education. As we enter the 21st century, and thanks to the development of new technologies, virtual education acquires new related dimensions, such as exploration and discovery, collaboration, connectivity, community, multisensory experiences, and authenticity, which are a response to the needs and demands of the learner.

When virtual teaching-learning environments, as spaces for the development of virtual education, are properly designed and implemented, the positive impact of their adoption is observed in schools, colleges, universities, and industrial training centers around the world. In addition, it is projected that the number of people seeking virtual education in the coming decades will outnumber those enrolled in traditional education by 4 to 1. Also, countries with large rural, illiterate, or poorly educated populations, coupled with a huge shortage of trained teachers, are beginning to embrace virtual education as a means of providing people with consistent educational opportunities. The following are some of the characteristics by which virtual education is beginning to expand:

1. *Lifelong learning*. In the world of the 21st century, lifelong learning is no longer a phrase to attract students, because it has also become a necessity for professionals and industries. While in the agrarian economy, children between the ages of 7 and 14 received knowledge that was sufficient for them to work most of their lives, in the industrial economy that age range was extended to students between the ages of 5 and 22. Meanwhile, in the information economy, and due to the rapid pace of change, it is necessary for people to constantly update their knowledge, because they are forced to maintain and enhance their skills and capabilities while developing new skills to meet the demands of the industry. Such lifelong learning becomes the norm as the age range of the school population increases.

2. *Learner-centered*. Virtual education is a learner-centered education and training system characterized by: 1) it is fundamentally self-directed, 2) it is more focused and purposeful, and 3) the teacher is a mediator of the process. In a world where information abounds and is continually increasing, the real role of the teacher must be as an advisor or mentor to guide students through oceans of information, but, fundamentally, to train them in how to best use that information. In addition, teachers must develop skills and abilities to get students to select important information and process it into knowledge that they leverage to solve problems, analyze and synthesize ideas, and project its use with foresight.

3. *Free access*. In this century, when Information Technologies has broken down physical boundaries, learning does not only take place in the classroom, because people take advantage of the ubiquity of mobile technologies to learn about everything, everywhere, and at any time. In response to this quality, in many countries, a wide range of courses and complete academic programs are offered virtually to students from all over the world. It is a movement in which free access to information is provided, driven in part by technological advances, the worldwide trend towards global standards, the increasing demand for access to education, and the growing industrial need to train employees in the management and use of new technologies.

4. *Revolution in knowledge*. This is generated by the convergence of information technologies, Computer Science, and cognitive sciences, and where the teaching-learning process goes through the phases of capturing, storing, imparting, sharing, accessing, and creating knowledge. In virtual education, the combination of technological developments and understanding of the learning process changes the relationship between people and knowledge. For it is not just a technical format but involves how it is presented, interacted with, and accessed through high degrees of interactivity. At the same time, this convergence changes the emphasis of education, because it breaks the traditional classroom, teacher-centered education, and teaching for the moment, and implements expanded, ubiquitous, and permanent teaching-education processes.

Up to this point the discourse on virtual education may have been understood and its characteristics and differences from traditional education are clear, but how to know whether or not this form of education is suitable for all people?

The most important thing to know is to characterize the segments of society: if you are a person who works or has family obligations, you are a good candidate; if you are an adult who needs to update your skills and abilities, the independence of virtual education may be your thing; if your obligations require you to continually update or develop new skills and abilities, you likely need virtual education to retrain; and if you are a traditional student, who must periodically surf the net to learn outside the classroom, this education likely is what you need.

According to McVay [51], virtual education involves a wide range of technologies and a large amount of software, however, students live their experience in some categories, about which they must have basic knowledge because they need them to achieve true learning:

1. *Hyperlinks*. Web pages are themselves printed material available online, but what makes them appealing to students is the ease of navigating the content and moving through it. This navigability is based on hyperlinks, which allow navigation from one page to another through links to the material. Another characteristic of web pages that facilitate virtual education is that they are themselves the basis of the content, and the new category of students prefers online content to paper guides or lecture notes because it is easier to search for the information they need.

2. *Sound*. Much of the content on web pages is audio, which can represent a lecture, music, videos, or language courses. For the learner to enjoy a learning experience, he/she should be aware of several ways to take advantage of audio, such as audio-conferencing, web calls, or the online meeting service. In this way, they can have two-way conversations with the teacher, with their classmates, or with any other person who can serve as a source of information.

3. *Video*. The tools available include still images (presentations) or moving images (videos), as well as images in real-time through live transmissions with audio. In this way, the student lives the experience through a video in which the teacher exposes a topic or demonstrates a procedure or a tutorial on how something works. There is also video-conferencing, a tool for mass meetings to discuss or resolve doubts.

4. *Data exchange*. In traditional education, the teacher receives feedback on how the students' learning is developing, either through observation or evaluation. In virtual education, teachers send and receive this same information, but electronically and with the advantage that the process is dynamic, in the sense that the teacher can use the data format that offers the best meaning. A well-designed and implemented virtual teaching-learning environment has advantages that cannot be realized in a face-to-face context, such as monitoring the students' work outside the classroom, time dedicated to consultations, teamwork time with classmates, project development, etc. Data exchange is done synchronously or asynchronously, and at the end, a report is generated with valuable information for the teacher and the educational process.

5. *Project-based learning*. The most common way to validate the achievement of learning outcomes in virtual education is through projects. The curriculum is structured in such a way that the contents are related to each other, it can be through an integrative project so that the student experiences integral learning in which he/she can apply what he/she learns in the development of the project. This process requires dedication on the part of the teacher, as well as effort on the part of the student, but in the end both enjoy a teaching-learning experience that rewards dedication and effort.

In the context of virtual education, the main skill that students must develop is to be *independent*, because to be successful in this context it is necessary that they enjoy searching for useful information on their own and that they achieve independent learning. The difference with face-to-face environments is that there their learning is guided by specific areas and knowledge bases that are autonomously defined by the curriculum and the teacher as those that the student needs. It is predictable, regimented learning, without wonder, and defined by someone who, most of the time, does not know what the student needs and without asking them at least what they want to

learn. Whereas independent learning is unpredictable, selected by the student, and untethered to what the teacher knows, or thinks he knows.

In any case, virtual education generates interrelationships and processes beyond its borders, as it involves issues such as lifelong learning, increased demand, education in developing countries, evaluation, the role of the teacher, commercialization, intellectual property, and flexibility; it is also true that it overlaps with technological developments, open source, integration techniques, and educational standards, among others. The basis of these activities is virtual teaching-learning environments, which also include teaching models, didactics, methods, policies, technical personnel, and economic resources, which influence their design, implementation, and use.

All this makes virtual education a topic of debate around the world and, if we add the thinking of teachers who do not accept losing their hegemony in the classroom, it is not surprising that it is part of discussions in which traditional education is *glorified* as the only way to educate people. Such statements might fit very well in 19th-century society, but today we would have to ask ourselves what it means to be an *educated person*. So, arguments such as that it moves away from social relationships, away from face-to-face education, or that it prioritizes technology over people, are mere conjectures from an unable education system, or unwilling, to re-invent itself for this century's society.

This debate originates in the contrast between two points of view about technology and how to make the best use of it in education, which we could call *diffusion* and *discussion*. Those who are against virtual education claim that it is a means of commoditizing education, deprofessionalizing the teacher, and improving the income of institutions so that technology is seen as a means of diffusion. They conceive the idea that the teacher is replaced by content, to which many people have access because technology becomes an on-demand content delivery mechanism. On the contrary, for the advocates of virtual education, the network is only a means of unprecedented discussion, which facilitates two-way communication at any time and place, and encourages research, dialogue, and analysis without the barriers of time and space.

But, although these views seem to disagree, the reality is that quality virtual education does not emerge from a magic formula, but is designed and implemented from both positions. When good content is created and meaningful dialogue is fostered, the ingredients for learning flourish.

2.1 QUALITY IN VIRTUAL EDUCATION

Virtual education is offered all over the world through a wide variety of courses and programs, from no-name institutions to well-established universities. People take up these offerings because they are flexible and adaptable to their convenience, however, many of these virtual courses are not designed with the levels of quality and maturity necessary to achieve true learning. They are more like attempts to enter the virtual education *fad*, and not because they are thought of as quality education.

Virtual education is an opportunity to massify education and to achieve the literacy needed by people all over the world. But it should not be launched as a *lifeline* without social responsibility, and much less in response to the whim of the government of the day. The design and structuring of virtual education require investment, research, and a new way of appreciating the student, and it is necessary to combine the experience of teachers in traditional education with curricula oriented to the development of learning outcomes, which serve the student to be formed as a

person and to be trained as a professional. In addition, to obtain the necessary benefit and quality, it must involve a high degree of interaction, training of teachers and administrators, and the necessary time for analysis and feedback on the results.

Because there is still no general agreement on what quality education means, the debate on the quality of virtual education is conducted through processes and benchmarks that have emerged from traditional education. In these discussions, concepts such as physical interaction, face-to-face listening to the teacher's discourse, prefabricated curricula, imposed content and rote assessments seem more important. In addition, instructional principles from the 19th century that are part of dying educational theories are still venerated.

The teaching-learning process of traditional education has been criticized for being a combination of face-to-face meetings that revolve around the teacher, forgetting what the student knows, needs, and wants to study. Therefore, the emergence of an alternative that focuses on the student, while taking away the protagonism of the institution and the teacher, must be viewed with suspicion and as an attempt to overthrow the dogma imposed for centuries. This does not mean that traditional education must end, but rather that it is time to revolutionize it and design a system that truly trains and prepares students for the New Age, regardless of whether the medium is face-to-face or virtual.

In virtual education, there is a need to develop some practices that, while not determinants of quality, can help achieve appropriate and personalized learning outcomes for students. Each of these practices is focused on the needs of the learner, has the support of the community and researchers, and has sufficient dissemination in the literature. The following quality assurance strategies represent many of the best practices learned in virtual education, combined with teaching methods and curricula that have withstood the test of time:

1. *Interactivity*. This characteristic is key to achieving a quality learning experience, and ample evidence is found in the fact that the more interactive education is, the more likely it is that the expected learning results will be achieved. The basis for this ranges from teacher availability to student engagement, thus structuring a teaching model in which there are no dominant positions because knowledge is equally available to all.

2. *Modularity*. This means that teaching should start from the re-knowledge of the student and, from there, design an individualized teaching model focused on small and modular content units, which must first be understood and comprehended before moving on to the next unit, with immediate and frequent feedback to students, active participation of them in the process of their learning, and with processes of verification and validation of learning through projects.

3. *Collaboration*. Learning outcomes are best achieved if the teaching model is cooperative and reciprocal among the actors. In this way, the learning model involves collaborative work and a teamwork context, since sharing ideas in a group setting enhances thinking and deepens understanding.

4. *Learning styles*. In the context of education, we have always learned that students learn in many different ways. Particularly in virtual education, technology has the potential to allow students to learn according to their learning style because they have access to well-organized images, texts, and multimedia; to experiences; to demonstrations of processes and procedures through interactive simulations; because they encourage self-reflection and self-evaluation; and because they work collaboratively in the design and development of projects.

5. *Verification and Validation of learning*. In order not to fall into the same mistakes of traditional assessment, where students are prepared for a test and not for life, the virtual teaching-learning environment must structure consistent and effective learning verification and validation processes. The point is that students need to know that what they are learning is necessary to progress in a field or master a subject. Education is of quality when assessment verifies the effectiveness of the teaching model and validates that students have achieved learning outcomes that ensure that it is possible to compare their training with graduates of similar careers around the world.

6. *Committed teachers*. Quality education is much more than curricula, content, and evaluation processes because the key to a good educational experience is the participation of committed teachers. It is erroneously believed that in virtual education the participation of teachers is reduced or, even worse, that they are eliminated from the teaching-learning process. The reality is that effective learning requires the intermediation of teachers, and while they are not engaged in monotonous lectures, in virtual education they become mentors who guide students toward appropriate research, investigation, project design, and further exploration in each area.

These strategies, together with well-designed virtual teaching-learning environments, have produced significant changes in the way virtual education is valued and analyzed. Society has realized that high-quality programs are offered in this modality, and students live daily a reality in which achieving a degree is not just a matter of paying, because the process to achieve it is difficult and demanding. In addition, institutions notice that flexible education is an opportunity for students to get closer to the system.

2.2 LEARNING PROCESSES

For learning outcomes to be efficient and effective for the professional performance of graduates, there remains a fundamental need for students to have a meaningful learning experience. That is why virtual education focuses on finding ways to provide them with such experiences because by finding ways to identify and create truly meaningful learning experiences, significant progress is made in the effort to improve the quality of education.

The point is that this goal is not achieved just by adapting or innovating a component of the educational scenario, because the phrase *meaningful learning* must demonstrate the value of the term learning as something truly significant for the lives of students. To achieve this goal, it is necessary:

1. Getting students to do more than memorize content in the short term. Research has shown that this type of learning only responds to the pressure of so-called *tests* because, after a short time, most students cannot remember the information they reviewed. In contrast, meaningful learning makes a difference in the way people live and the kind of life they can live. What is needed is for everything students learn to become part of how they think, what they can and want to do, what they believe to be true about life, and what they value. To achieve this, students need to develop multiple learning styles that allow them to do more than just listen and memorize information.

2. Help students connect what they learn with their *life projects*, not with their *obligation to pass* the learning process. This means that education must take advantage of the experience, what the student knows and what the student needs when designing the curriculum, content, and

assessment, and then link the learning that the student achieves in the learning process with the needs of industry and society.

3. Recognize that a meaningful learning experience has both process and outcome dimensions with its characteristics. In the former, students participate in their learning and the learning process has a high level of energy; while in the latter, the learning process generates significant changes in the student's life, while having a high-value potential. In these learning experiences students not only learn throughout the process but in the end, they will have changed in some way, because they learned something meaningful.

When designing a learning process, it is necessary to define what we want students to achieve and what we want them to retain beyond their thinking. In this case, the process should be structured through a taxonomy of meaningful learning, in which each category contains several more specific types of learning, related in some way and with differentiated value for the learner:

1. *Prior knowledge*. What students know before the learning process cannot be ignored because it is the basis for most other types of learning. The term *knowledge refers* to the ability of learners to understand, comprehend and remember specific information and ideas. That is why people need to acquire valid basic knowledge before entering the education system because it provides them with the basic understanding needed to select a program or achieve other types of learning.

2. *Application*. Prior knowledge makes it easier for students to learn how to engage in some new type of intellectual, physical, or social action. Engaging in various types of thinking is an important form of applicative learning, which also includes developing skills such as communication or learning to manipulate complex situations.

3. *Integration*. When they see and understand the connections between different things, students develop an important type of learning. That is why the curriculum needs to be integrated, in the sense of getting students to link what they know and learn from a specific course with what they know and learn in other courses. In this way, they can establish new and diverse connections that give them a new form of power, especially intellectual power.

4. *Human formation*. When students assimilate something important about themselves or others, they learn to live and interact more effectively in society, because they discover the personal and social implications of what they have learned. This happens because what they learn or how they learn allows them to structure a different understanding of themselves, as well as to project a new vision of whom they want to be. They also develop a better understanding of others to define how and why to interact with them, because they have learned about the human significance of what they are learning.

5. *Valuing*. A quality learning experience changes the degree to which students value things, and they demonstrate this in the form of new feelings, interests, or values. This means that, after the learning process, students value things more than they did before because they have the energy they need to learn more about them and integrate them into their lives.

6. *Learning to learn*. Through a meaningful learning experience, students also learn about the learning process itself. In virtual education, they may be learning how to be better learners, how to engage in a particular type of research, or how to become independent learners, which is an important way to learn how to learn and to continue learning throughout life.

Because in virtual education learning outcomes represent the central axis of verification and validation of what is achieved by the learner in a learning process, they are at the same time integrated into quality systems. But this does not mean that quality assurance simply assumes a directive role because, in any learning process, it must follow advances in curriculum design, the development of teaching models, the structuring of assessment, and the socialization of results while establishing and maintaining standards to increase the overall level of quality of learning processes. In this way, the quality of these processes plays an important role in supporting the use of learning outcomes, because it establishes guidelines and good practices for design.

In any case, before starting to design a virtual learning process, the didactics to be used in it must first be defined, because the level of interactivity to be imbued depends on it. Teaching techniques and methods for virtual education include:

- Information on a website
- Practices for new concepts
- Synchronous or asynchronous discussions
- One-to-one, one-to-many or many-to-one communications
- Schedules
- Verification and validation of learning
- Projects and research
- Physical and virtual learning resources

In a learning process, some or all of them can be used depending on the needs of the context and the students. Furthermore, the development of the process should not be done alone and, although the necessary technology is complicated, the opportunity for innovation is so great that it is not worth leaving it in the hands of an isolated trial-and-error effort. For this reason, it is recommended to analyze other similar learning processes, and to dialogue with peers, colleagues, or institutions to discuss the design of the process. In the universe of virtual education, a kind of community persists in which most participants are willing to collaborate and share their experiences.

From this perspective, and taking into account that virtual education is global in every possible way, learning processes must be conceived with this characteristic in mind. A hasty mistake is to think locally when analyzing and structuring a learning process, be it a course, a seminar, an internship, or a program, to then offer it globally. It is often wrong to even think nationally, because even learners from different regions have different cultural traits and, by taking a biased learning process, can easily lose interest in completing it. It is recommended to take into account the following principles in the structuring of virtual learning processes:

1. *Transculturality*. The basis for structuring attractive virtual learning processes is that they should be transcultural, because, although there is a possibility that only local students will take it, it may also be of interest to national and global students. Therefore, it is necessary to take into account factors such as: 1) educational practices and systems, because they differ widely from country to country; 2) cultural context, to respect the fact that people experience strong emotional reactions when their cultural values are violated or when the expected behaviors of their cultures are ignored, so the learning process must be structured neutrally in this regard; 3) individualism, because learners may belong to a society in which ties with others are relatively loose, which may generate negative reactions to, for example, exaggerated interactivity; and 4) cultural stratum, a factor in which issues such as language proficiency, educational level, time commitment, previous experiences, ... must be involved.

2. *Multifaceted*. Because when learners come from significantly different cultures multifaceted virtual interaction becomes especially important. This takes advantage of the lack of face-to-face conversations, observation of body language and facial expressions, or physical interaction, to *smooth out* communication obstacles. A learning process in which students feel that these facets are diluted is more engaging and stimulating.

3. *Globality*. Because if the learning process is taken by students from different countries and even continents, issues such as time zones, language, denomination, evaluation, and assessment change, then, as far as possible, they should be involved in its structuring.

4. *Language*. Language skills are a key issue in traditional education, where students who wish to study in another country have to master their native language. In virtual education something similar happens, but with the exception that students have more time to review the learning processes and reach the necessary understanding of the content, even if it is in another language. In any case, it is recommended to make it clear from the beginning of the process that will be offered in only one language, as well as the opportunities for those who do not master it. Some learning processes are offered in several languages, but this makes it necessary to adapt the content, design, and evaluation to the culture of the students in each language.

5. *Flexibility*. Although in traditional education it is still accepted that the teacher is the one who knows and the student is the one who learns, in virtual education the previous knowledge that students have about the content of the learning process is recognized and valued. That is why it is necessary to structure it as flexibly as possible since it can be taken by people with high knowledge or experience, as well as by those who are just approaching the content.

6. *Verification and validation of learning*. Each educational system defines its evaluation process, which may be different from the one used in the country where the learning process is offered. Therefore, students are familiar with how they are evaluated, graded, and assessed in each one. In the structuring of virtual learning processes, these aspects must be included and a way must be found, if possible, to unify them, otherwise, the achievement of learning outcomes must be certified in the format and value of each student's country of origin.

Many institutions and teachers mistakenly assume that virtual education is simply offering the same curriculum as traditional education, so they omit these principles. The reality is that the curriculum is not what is converted to digital, but rather a different teaching model must be designed, new didactics, changing the mindset of teachers and the evaluation system, among others, and therefore all this means that the learning processes must also change. The point is that an effective and engaging e-learning process implies changing the paradigm in terms of how the related content and material are delivered. Instead of simply moving the traditional learning process to virtual education, institutions, teachers, and designers should take the following steps:

1. *Define learning outcomes*. Any good learning process should be structured with the end in mind, what the students will learn, and what skills, abilities, and capacities they are expected to develop, so the main thing is to define the learning outcome. From there, most of the questions that may arise in the work team are cleared up.

2. *Select the appropriate material*. When presenting the learning process to the students, it is not necessary to upload a detailed outline describing the topics and contents of each teaching-learning session; the titles of the sections are sufficient because this gives a general idea of what will be considered and discussed. In any case, the material should be more open than that

used in traditional education, because in virtual education a greater margin for exploration is needed. So, choosing the right material and presenting it should enable students to achieve the defined learning outcomes.

3. *Structuring the learning process*. In virtual education, the concept, deeply rooted in traditional education, that learning processes in science, mathematics, art, or music cannot be structured in the format of reading and discussion, is broken. The reason is that virtual learning processes are structured after defining the learning outcomes and selecting the appropriate material. The same goes for experimentation since in traditional education many learning processes do not use it. Therefore, their structure must integrate multidimensionality and transdisciplinarity, because students need to complement them with the other processes they attend.

4. *Design how to verify and validate*. As students advance in the learning process, they want to know their progress, so it is necessary to design a technique that allows them to know how they are doing, as well as how they should finish. Based on the prior knowledge they demonstrated at the beginning of the process, the technique should offer them the opportunity, first, to *verify* the achievement of the learning outcomes and, second, to *validate it.* Verification refers to *how well they understand* the learning process they took, i.e., they must demonstrate that they can describe it in their own words. Validation is related to *how well they understand* the process, i.e., what they know how to do with the knowledge acquired.

To these steps, we must add design activities, the use of technologies, interactivity, independent work, teamwork, and integration in the development of a project. This procedure is different from how a traditional learning process is designed, because there the teacher is the one who defines, almost autonomously, what to teach and what, how, and when to evaluate, ignoring the other actors of the educational system.

In addition, a real-world characteristic that must be taken into account in the design and structuring of virtual learning processes is social presence, because it is a strong predictor of satisfaction in virtual education. For students to be attracted to a learning process as a worthwhile experience, they need to feel as if they are part of a community, i.e., they need to see and hear others and the teacher. This feeling creates a positive cognitive dissonance in which the learner struggles with real reality and virtual reality, which opens cognitive channels that facilitate the achievement of learning outcomes.

A learning process that includes social presence offers students the perceptual illusion of non-mediation, i.e., the feeling that their learning is unmediated, so they respond as if the medium does not exist. This is because virtuality is *transparent* and provides a window into the learning process, causing students to perceive the medium as a social entity, rather than a technology. Therefore, social presence helps the teacher to understand the possibilities of student learning.

2.3 LEARNING OUTCOMES

Since it is not easy to materialize a common understanding of the term *competencies*, so fashionable at the end of the last century to verify student learning, and which became a real problem for the education system, the recommendation of various international organizations, the Bologna agreement, and many researchers and specialized authors, is that the teaching-learning process should be evaluated based on learning outcomes. As a result, this concept gained importance in education, therefore, the question we should ask graduates today is not: what did

you do to obtain your degree? But rather: what can you do now that you have obtained your degree?

This is a shift in focus that is more relevant to the labor market, which takes on flexible tones when integrating concepts such as lifelong learning, non-traditional learning, project-based learning, challenge-based learning, intelligent learning, situated learning, expanded education and ubiquitous learning, as well as other forms of *non-formal* educational experiences.

Since the signing of the Bologna treaty, which formulated policies aimed at improving the efficiency and effectiveness of education, countries have been obliged to integrate the concept of learning outcomes and their significant constituent elements into all programs, and curricula have had to be redesigned to reflect the initiative. This generated a small revolution in the traditional education system, where how modules and programs are designed is based on content and competencies.

Since the 19th century, teachers decided that through the content it was possible to teach, plan how to teach, and evaluate the results, an approach centered on what the teacher knows and an evaluation in terms of how well students *absorb* the content. And that way of delivering education may have worked at the time, but from the mid-twentieth century, criticisms began to emerge, in the sense that it was no longer so easy to identify precisely what the student had to be able to do to pass a learning process.

An international trend then emerged that sought to shift the focus from a teacher-centered education to a student-centered one, i.e., what the student is expected to be able to do at the end of a learning process, which is why some call it an *outcome-based approach*. This concept of intended learning outcomes, abbreviated as learning results, is used to express precisely what the student is expected to be able to do at the end of a teaching-learning process.

Although in the literature it is not possible to find a definition of learning outcomes that are considered general and do not differ significantly from others, it is concluded that: 1) learning outcomes focus on what the student has achieved and not on the intentions of the teacher or the curriculum, and 2) learning outcomes focus on what the student can demonstrate at the end of a learning activity. Therefore, the following definition is assumed in this book: *Learning outcomes are the capabilities, skills, and abilities that a student can demonstrate after experiencing a learning process*.

In this definition, it is clear that learning outcomes focus on explicit and detailed questions of what students learn and what the learning activity seeks to develop, and then verify and validate. It should also be noted that learning outcomes are an integral part of a series of new guidelines that seek to revolutionize the education system. This represents a paradigm shift from traditional ways of measuring and expressing learning, which emphasize education in hours and quantitative grades, to result-centered techniques that use learning outcomes. In other words, the emphasis shifts from content, what the teacher teaches, to results, what the student can do, a paradigm that virtual education embraces.

The reason is that in virtual education the teaching process is centered on the student while promoting the idea of a teacher as facilitator or tutor of the learning process, as it recognizes that most of the learning takes place without his or her presence. On the other hand, in virtual education students actively participate in the planning and management of their learning, and assume greater responsibilities than in traditional education, where they are only passive actors.

Therefore, it is logical to assume that student-centered learning needs to use learning outcomes, from which follows the need to know how students learn, their needs, previous knowledge, and what they want to learn, to design and implement virtual teaching-learning environments that facilitate the achievement of learning outcomes. In addition, a cascade process is generated in which education is seen as a multidimensional-transdisciplinary scenario in which didactics, teaching models, curriculum, and contents are merged for an adequate verification and validation of learning outcomes. But these learning outcomes should be used only as a tool to develop and improve education, not as a goal in itself.

Currently, learning outcomes are the alternative to qualify programs and institutions, because they provide a meeting place for expectations and functionalities related to virtual education. Therefore, a good practice is to involve students, teachers, administrators, employers, and society in the definition of learning outcomes and their verification and validation, to structure a process of practical reflection and co-creation where all actors are co-responsible for the quality of the learning process.

Likewise, the learning outcomes are consistent with national and international qualification frameworks, because they are formulated as a process in which the expected results of each learning process are linked to those of the program, which in turn are compared with the qualification frameworks in a given domain.

As an obligatory alternative, it must be recognized that in traditional education, learning outcomes have a high value in educational reform processes, although it cannot be concluded that the implementation and analysis of their systemic use are the same in all countries, institutions, and programs. Many appeal to ideas of social constructivism in which, if the concept has been accepted by the collective, then it becomes an institutional fact. And while this interpretation may seem correct, the evidence shows that the level of understanding, or lack thereof, along with haphazard application in practice, remains a problem in many countries and institutions, and its formulation and application are determined by one's context and culture.

In this way, learning outcomes are perceived as one more alternative among the different measures that aim to support the integration, harmonization, and alignment of initiatives in education. In any case, learning outcomes are important in the creation of qualification frameworks, and the approach promises to better respond to the needs of society and to lead the necessary transformation of teaching models and curricula. That is why the general perception is that learning outcomes are a salient feature of the education system reform process.

In traditional education, the curriculum emphasizes memorization and is teacher-centered, but in virtual education, a product outside of educational reforms, a paradigm shift is being advocated in which the emphasis of teaching is learning, through models in which the student is the center. Inevitably, this paradigm generates changes associated with how the curriculum is designed, in addition to recognizing what the student knows and structuring teaching models more in line with his or her learning style. In the development of these practices, learning outcomes are expected to be the axis around which knowledge, understanding, skills, and abilities are developed to achieve quality education.

The reason is that learning outcomes have the potential to contribute to the educational revolution since they play an important role in clearly defining the teaching-learning-assessment relationship. But they cannot be considered by themselves as the *medicine* that will alleviate all

the ills of the education system, although they are a building block on which to begin an international agenda to structure a system that truly trains people and professionals for the New World Order.

On the other hand, the evaluation of learning outcomes is a topic of interest in virtual education, since it is used as a method to assess its quality and to establish continuous improvement processes. To meet the trend of increasing global integration and exchange of students and teachers, institutions face the challenge of designing or adapting quality standards in assessment and demonstrating that students achieve the expected learning.

In virtual teaching-learning environments, the process of verification and validation of learning outcomes is an integral part of education, because it provides the institution with permanent information to analyze tacit assumptions about its efficiency and effectiveness. It also allows it to structure continuous improvement processes over time. Intentionally assessing learning outcomes in an effective and well-planned manner is of broad benefit to virtual education, because it allows:

- Ensure that students develop the skills, abilities, capacities, ideas, attitudes, and values necessary for their professional performance.
- Document evidence of verification and validation of student learning, based on the actual results they achieve.
- Improve the effectiveness of the teaching model based on actual student performance.
- Demonstrate the quality of the processes that virtual education has structured.
- To show industry and society that graduates are adequately trained and qualified.
- Convince students to enroll in this mode of education.
- To set an example in terms of current teaching-learning priorities.

By placing learning outcomes as the central axis in virtual education, all aspects of the teaching-learning process are involved and processes for improving the quality of education are generated. In this way, verification and validation of learning outcomes are one more element in virtual education, included in a broader process that begins with the formulation of the outcomes and involves the re-knowledge of students and their responsibility for their learning, and the development of a teaching model adapted to those outcomes. In addition, curricula and content form a bridge to the achievement of the formulated outcomes. That is why in virtual education the assessment system is fully aligned with student-centered education, getting them to demonstrate achievement validly and reliably.

Verification and validation of learning outcomes can be seen as only one aspect of student-centered learning, but from the macro, it is an aspect that provides the interface for social scrutiny. The achievement of learning outcomes is what students take with them when they enter the labor market, which they will enrich in the development of their functions through lifelong learning, so virtual education assimilates them as transparent and transferable to society. In any case, the following aspects should be mentioned about the formulation and evaluation of learning outcomes:

1. It is important to harmonize the difference between learning outcomes at different educational levels because there can be a tendency to describe the lower levels as *light* versions of those at the higher level. Therefore, the learning outcomes at each level should be described based on the specific orientation and social relevance of education at each level.

2. As the level of education becomes more professional, the learning outcomes are intended to be more detailed and specific. This can improve recognition in a professional field, but it must be ensured that it offers sufficient freedom to teachers and students.

3. Learning outcomes are often formulated in a very generic and cross-cutting way, so they lack connection to specific learning outcomes in a given sector, making them difficult to transfer.

4. The skills, abilities, and capabilities demanded by the New World Order [3] often refer to learning outcomes that are difficult to achieve in a given domain. That is why benchmarking of outcomes must also take into account the attitudes, character, and personality of the learner.

A key issue here is that for virtual education the use of explicit statements of learning outcomes helps to ensure consistency of education and training. It also helps in curriculum design, because it is easier to identify areas of overlap between the learning processes and the program. Learning outcomes also help instructional designers to accurately determine the purpose of content, to project the integration of different courses, and to assess students' progress in their achievement. In addition, when learning outcomes are properly designed, they promote reflection on assessment and the development of appropriate assessment criteria.

Just as in traditional education, in virtual education, assessment must be given to the achievement of results, or grades. It is a process that helps ensure quality because it increases transparency and comparability of standards between and within both educational models. Outcome-based grading offers more credibility and utility than traditional test-based grading. On the other hand, students benefit from knowing in advance the full set of statements of what they will be able to achieve after completing a successful learning process, providing them with clear information for selecting a particular program and thus leading to more effective learning.

It should be noted that the positive and negative aspects found in the literature about learning outcomes are a summary representation of more general statements, but in practice, many of them are improved or overcome, provided that learning outcomes are developed with care and sensitivity. It all depends on how they are designed and how they include key aspects of education, such as knowledge, skills, abilities, capabilities, attitudes, and understanding. Poorly designed, narrow, and limited learning outcomes are not appropriate for virtual education, because, in this educational model, aspects such as creativity and imaginative leaps are highly valued.

2.4 CURRICULUM

As in traditional education, in virtual education the curriculum is the support on which a program is articulated, so it must be structured in an organized way and have an attractive and easy-to-understand format for students and teachers. It must be taken into account that the instructions that the teacher provides verbally in traditional education must be clearly described in the curriculum in virtual education. This makes it easier for students to concentrate on the content instead of *harassing* the teacher with questions.

A well-structured curriculum is one of the key features for successful learning and achievement of learning outcomes, so it is an important element in virtual education to build an optimal learning path for students. Together with communication and collaboration tools, the teaching model, didactics, and assessment tools, the curriculum is at the center of a virtual teaching-learning environment. Therefore, and as a result of the integration of Information Technologies in virtual education, administrators and teachers are obliged to understand them, implement them, and

think of more efficient and precise mechanisms for the design, structuring, and implementation of curricula.

Both teaching and learning need varied methods and ways of working corresponding to the different learning styles and levels of knowledge of the students, therefore, the curriculum becomes the navigation chart that guides the teaching processes. Added to this is the fact that every day, and as a result of the changes in the New Age that increase the interest in education and new ways of accessing it, virtual education is an alternative to respond to the inability of traditional education to meet this demand. Therefore, the curriculum becomes the differentiating component, which responds to the needs of students and enhances the use of technologies to achieve learning outcomes in line with the expectations of industry and society.

Hence, the development and maintenance of virtual education, in addition to infrastructure and economic factors, depending the quality of the curriculum, so it must be structured to ensure the efficiency and effectiveness of the teaching model and to offer learning processes that help develop learning outcomes through creativity, initiative, flexibility, expansion and continuous improvement. In addition, the teaching model must be flexible to adapt to new technological developments and new scientific discoveries in each area of knowledge.

It is also important to keep in mind that virtual education has created a new paradigm that provides ubiquitous learning opportunities for each person, anytime and anywhere, so the preparation of the background and the necessary basis for the successful implementation of the curriculum requires knowledge of the factors that are characteristic of it. That is, it must face and solve cultural, financial, structural, IT, legal, motivational and knowledge challenges, which are part of the context of this type of education.

In this educational environment, students develop the capacity to adapt to the context and learn at their own pace, taking advantage of the learning by projects, and the teacher must apply a particular teaching model that helps students to develop the defined learning outcomes. All this is framed and directed by a well-structured curriculum, in which the students' learning activities can be directed, potentiated, or corrected.

Many institutions consider that structuring the curriculum in virtual education is simply a matter of integrating technologies into the curriculum planning process, but while technologies facilitate preparation for the teaching-learning process, the approach must be varied because this type of education integrates many features that are barely mentioned in traditional education. For example, one must have a correct understanding of virtual space and multimedia, hypermedia, and internet communication capabilities, and integrate them effectively into the curriculum. In addition, the selection of an approach to curriculum design depends heavily on a proper understanding of the capabilities of technologies and student-centered learning theories.

In the design of the curriculum, it is necessary to identify the elements, the material, the contents, and the correct sequence for the teaching processes. Although many designers consider that the learning outcomes are the most important element, it is also necessary to consider how they will be achieved, so the curriculum must be clear and guide the actors on issues such as the necessary didactics and how to evaluate and assess what has been achieved in the learning processes. Although difficulties such as need and agreement, complexity, clarity, quality, and usefulness of the materials may arise during implementation, the structuring of the curriculum must have the necessary solidity to overcome them through dialogue agreements between the parties.

The design and structuring of the curriculum for virtual education must also include the analysis and discussion of some important components, which need detailed planning and evaluation, such as organizational, technical, and formative requirements. The reason is that these requirements play an important role as the backbone and circuit of the learning processes, and are an important factor in defining the learning outcomes.

It is common that in traditional education the curriculum is designed to respond to the specific needs of the institution and teachers, rather than to the needs and expectations of students and society. For the curriculum in virtual education to provide credibility and access to the depth and meaning of IT-mediated education, it must constantly respond to the needs of students and ensure that they are formed as individuals and trained as professionals, in addition to creating active learning communities in which society has much to contribute. Therefore, curriculum designers and planners for virtual education must include in the agenda the review and redefinition of these elements and characteristics.

On the other hand, and given the evidence of mistakes in initiatives to structure virtual learning environments that do not generate a sustainable quality impact in practice, the cumulative effect of the problems and pressures in education is leading researchers to rethink the design and structuring of virtual teaching-learning environments. This is because the new category of learners comes from a broader social spectrum than before, and there is a high proportion of so-called non-traditional learners from different social backgrounds, such as employees returning to education and those seeking professional upgrading and other forms of lifelong learning. Therefore, there is also a need to broaden the educational offer, and the option that many institutions see as most likely is virtual education.

But this diversity of students who do not have the time to attend traditional education, together with the advantages offered by technologies, does not mean that virtual education should be structured like traditional education, because the motivations and needs of students who take this option are different from those who are still inclined and have the disposition, to study traditionally. Although job aspirations and professional needs have become motivators for students to enter the education system, institutions need to realize that they need to structure quality virtual teaching-learning environments, because it is not only about delivering a diploma or a degree but about educating and training people who will face the challenges of the New World Order.

An important issue in this discussion is the proposition that the curriculum design for virtual education is different from that of traditional education. We must forget the excessive protagonism of the teacher and make the student the center of learning, and design a curriculum in which technology is an ally, not the tool through which teaching is imparted, because this, as happens in most institutions, is simply transferring the physical environment of the learning process in the classroom to a virtual work environment, but with the same problems of traditional teaching, with poorly designed learning processes and learning outcomes not achieved.

2.5 TEACHING MODEL

Due to the current educational needs in the sense of greater participation and inclusion, and the academic challenges generated, on the one hand, by the new category of students and, on the other, by the New World Order, the education system needs governmental strategies to openly fulfill its objective of training people and preparing professionals. In particular, because traditional teaching models are inadequate to achieve this goal and, in general, because there are

countervailing pressures on the education sector in the society to structure and design a quality system. These pressures, which may be political, economic, or commercial, are leading educational administrators to select and adopt systems that underestimate academic challenges and lead only to banal teaching processes adapted to fashionable technologies.

But there is no shortage of speculation and theorizing about the current role of virtual education, in part because when one analyzes the institutions in which it is delivered a different picture emerges than what is promised. Many of these institutions call themselves virtual, but what they are is a continuum of the traditional institution, with some elements of virtual teaching, which are not considered a structure where all teaching and learning occurs in a true virtual teaching-learning environment. In the same way, teachers consider that the teaching model, which they have used since the 19th century in traditional education, works the same for virtual education.

These environments should be of special interest to teachers because they are in charge of creating, selecting, and providing teaching processes in which effective learning outcomes are developed. In addition, with an adequate curriculum and a revolutionary teaching model, virtual environments can establish an enabling framework for students' prior knowledge to become a tool for directing teaching-learning actions. Teachers should be aware that learning occurs with or without them, so the teaching model should be how the process is formalized, and the degree to which learning approaches the achievement of learning outcomes is enhanced.

The widespread interest in Information Technologies in education is only to take advantage of the seemingly limitless possibilities they offer for institutions to fulfill their promises of coverage and inclusion. The absurd idea that these environments open the doors of learning for all has been embraced with much enthusiasm, to the point that it is not uncommon for many institutions to offer virtual education with promises that it provides new, authentic, interesting, motivating, and successful educational activities. But technology alone is not the foundation that supports quality education, because a virtual environment comes with implicit assumptions that must be addressed.

One of these assumptions is to consider that students, simply because their lives are surrounded, and often shaped, by technology, are motivated to study virtually. Motivation arises from the selectivity of human behavior, because at any given moment in life, people are surrounded by a wide range of stimuli, some of which they notice, some of which they ignore, and many of which do not even affect their awareness. Therefore, each person has a history involved in any experience he or she lives and to which he or she incorporates values, interests, emotions, and attitudes. For example, when two people experience the same situation, what may be novel and disconcerting to one may be familiar and of great value to the other.

On most occasions, people pay more attention in response to specific properties of a received stimulus. In education it may be the response to a bright light, an intense color, or perhaps a loud sound; so bright, intense, and loud imply that the learner evaluates the stimulus relative to others that do not attract his or her attention. In addition, it may be that paying more attention and investigating is a response based on their expectations or evaluations. For all these reasons, in virtual education, with all the distractors it may involve, the teaching model must be structured and designed differently than in traditional education.

In the virtual teaching model, the salience or predictability of the learning environment cannot be ignored, because the understanding of the typical selectivity of human behavior is lost, and there is a risk that it becomes especially critical to capture the attention of the learner. The teacher must

be able to understand how students respond to the particularities of the teaching model and teaching processes because it provides knowledge that can be used to understand the achievement of learning outcomes. Here it is convenient to identify which qualities of the stimulus arouse curiosity and interest in the student, create a desire for achievement or generate anxiety because this is important to self-evaluate if the teaching model is well structured. Some stimulus qualities to take into account in the design of a teaching model are:

1. *Curiosity*. This quality refers to motivational processes that cause the student to be motivated to study and investigate a specific topic or situation. Curiosity generates a variable exploratory behavior, in which the student wants to approach the novelty to elucidate the ambiguity, complexity, or incongruity of the situation. The activities of the teaching model should allow the teacher to identify students who are curious about a given situation, as well as students who are not very curious because the level of curiosity that will be taken into account in the exploratory activities depend on this knowledge.

2. *Interest*. This is a construct related to education that is used to explain the impact of motivation on learning, suggesting that teaching processes that arouse students' interest offer a greater possibility that they will achieve learning outcomes. Therefore, the teaching model should be structured to maximize students' interest in the learning processes and achieve greater knowledge. We can speak of two types of interest that contribute to learning: situational and individual. The former arises from issues such as the virtual teaching-learning environment, contents, interactivity, etc., and the latter arises from the teaching model, evaluation, teaching processes, didactics, etc. That is why the teaching model must be structured to maintain the active participation of students, the desire to find out more about the subject, and the possibility of validating knowledge in practice.

3. *Achievement desires*. Desires are related to students' learning purposes, which by nature are diverse and specific. For example, students may want to master, understand, or improve a domain or goal, or they may want to perform well in the teaching process. These purposes may take the form of public recognition, outperforming their peers, or not appearing defeated. But it may also be that they do not want to try too hard and keep their level of learning to what is necessary to achieve the results. In the New Era, the new category of learners also considers combinations of social goals, because for them the learning process is also a social situation, which they can show to their peers and family members through social networks. These desires for achievement are characteristics of students that cannot go unnoticed when designing the teaching model and selecting didactics in any teaching process.

4. *Anxiety*. This is a stimulus quality that, to some extent, can enhance or impair learning. When a student feels frustrated in a learning process, his level of anxiety increases, he diverts attention from the process, and his performance decreases. This can happen because the student does not have an adequate level of prior knowledge, because he/she has personal problems or because he/she is living in some social situation that substantially impacts his/her learning capabilities. An attentive teacher with an adequate teaching model has the possibility of identifying these situations in time and organizing activities to advise and distract the student so that he/she does not lose the course of learning.

Although these are not the only qualities that stimulate learning, they illustrate the premise that to achieve quality virtual education, it must be recognized that both the situation and the individual contribute to the actual learning experience. Therefore, motivational issues, both

situational and individual, must be included in the design of the teaching model for virtual environments. In the structure of the teaching model, the teacher must take into account that students perceive, evaluate and interact with and in the virtual teaching-learning environment, and in each process select the necessary contributions that motivate them to learn.

Now, given that the medium used by students to access virtual education is technology, both the curriculum and the teaching model should allow the teacher to identify how they use it and their attitude towards it because this provides information to understand the motivation and interactivity of students in the virtual environment. A common mistake made by institutions is to believe that students, because they live surrounded by technology, have a positive attitude towards it, that they know how to use it, and, even worse, that they have the purchasing power to compare it. This is not true in all cases, so the teaching model must incorporate familiarization and conviction activities so that students' motivation does not wane.

Added to this is the fact that any learning process must focus on the key factors of the environment and their relationship with the cognitive abilities of the student, and take into account that the most important factor in achieving cognitive results is not the medium used, but the quality of the message delivered. This quality must be possessed by the teaching model because the quality of the message is determined by how it is adjusted to the cognitive abilities of the students, but it must be supported by the characteristics of the materials and didactics because their selection and transmission can facilitate or inhibit learning.

From this perspective, it is accepted that the student is a constructor-discoverer of knowledge because he has at his disposal enormous amounts of information from which he constructs his representation and integrates it into his learning. Therefore, a teaching model that takes into account, for example, the theory of dual coding [53] to structure and send the message, uses visual and verbal systems that help students to extract the information they are interested in. Otherwise, and being immersed in this volume of information, they will only find distractions and, consequently, lose motivation.

When structuring the teaching model, it should also be taken into account that interactivity is a basic component of virtual teaching-learning environments and that it is a feature that generates a greater or lesser degree of motivation in students. Many institutions pretend to use static virtual learning environments (note that the *teaching* component is not included), with the erroneous idea that just by accessing them from a computer the student is motivated to learn. But simple or non-existent interactivity, as in this case, does not allow the student to control the flow of the message, because it would be like being in a traditional classroom listening to the teacher's speech.

The degree of interactivity of the teaching model should allow the student to *operate* the effects of the learning environment, i.e., the amount and actual processing of the information, and that he/she is motivated to retrieve during learning. But, in terms of processing, a learning process places a level of cognitive load on students, and, if the teaching model is designed to make that load very large and in a short time, the student must try to organize and clarify it in a hurry, which interferes with learning. Also, a complicated structure of the learning processes prevents students from building a coherent mental model of the learning in the message. That is why the teaching model must be coherent between the cognitive load of the message and the pace at which the student constructs knowledge. In these cases, the student achieves a deeper understanding, because the volume of the transfer does not exceed his learning pace.

Another important feature of the teaching model is to allow the teacher to identify the specific cognitive processes that must be integrated into the virtual environment to impact students' knowledge and understanding. For example, identifying the cognitive load of the learning processes that affect learning allows the teacher to decide whether to use text, images, or narratives to present the message because together they generate more cognitive load in the process.

Thus, the structure and design of an efficient and effective e-learning model will never be a simple task. A broad set of specifications that can only integrate the teacher's experience and capabilities will always have to be taken into account. The teaching model must be structured with intelligent education in mind, in which the individual characteristics of the students are important, but also their prior knowledge, spatial skills, and cultural background. But an innovative teaching model will be of no use if the teaching-learning environment does not have the quality and structure to implement it. Therefore, the virtual education environment needs a match the design parameters and the cognitive abilities of the students, in such a way that it awakens in them adequate levels of interest and curiosity to learn.

Despite all that has been said so far about the design of a teaching model for virtual education, which may not be sufficient but is necessary, other important premises must be included in its structure:

1. *Personalized learning*. One of the most important implications of the Internet has been to offer users unlimited options in any area of interest. A consumer with a credit card and a computer has at his disposal a universe of purchasing possibilities; the entrepreneur with innovative ideas is not limited by physical boundaries to offer his products; families communicate instantly from any part of the planet; and students have so much information that, if they do not design an organized search plan, they can be *shipwrecked* in the attempt. That is why a good teaching model must offer a wide variety of possibilities, including personalized or self-designed materials and projects that awaken and strengthen students' interest in learning.

   The teaching model cannot fall into the error of considering students as consumers of information, but as seekers of knowledge and offering them personalized learning opportunities. And, although the number of options and ways to achieve this goal is almost unlimited, very few of them succeed in making students develop learning. The point is that virtual education is a multidimensional world of learning, as opposed to the one-dimensional world of traditional education in which, supposedly, tests measure results, but not necessarily real learning, because the teaching model is invasive and forced.

2. *Collaborative learning*. Because the New World Order has generated profound cultural changes related to new learning models, the challenge of education is to identify and understand the preferences of dispersed and diverse learners. Virtual education assumes that learning is not one-size-fits-all, so it is necessary to design a teaching model that appreciates and encourages learning in all its sizes and varieties, i.e., *collaborative learning*. The difficult part in structuring and designing this model, as well as the most important skill for teachers to develop, is to figure out how to make individual students, with their abilities, interests, and motivations, work collaboratively with other students who have different characteristics.

   But this does not seem to be a complicated issue, because in this century the model of collaborative learning among disparate peers occurs routinely, albeit casually, in social networks. The teaching model should learn from the good practices of these experiences and

teachers should develop didactics to enhance them. Of course, the proposal is not to invade, much less imitate the sites where this interaction takes place because it would cause greater demotivation in students. One option is to carefully ethnographically investigate the types of interactions that occur there and design new ways of thinking about collaborative learning.

Just as it is important to appreciate and nurture the diverse and sometimes eccentric learning abilities and interests of individual students, it is also important to design teaching models that encourage collaboration among them. One way to achieve this is to involve students in the learning process, encouraging them to explore and analyze their talents, and to use challenge-based and project-based education to work in teams; to find the best way to harness their talents and contribute to the development of projects. In this way, the teaching model is innovated, because the achievement of learning outcomes is developed as a continuous, personalized, and collaborative project.

3. *Authorship*. It is difficult to define who owns the ideas in a collaborative work environment, especially when this work produces products such as books or articles in a kind of collective authorship. This issue should be taken into account when structuring the teaching model, because in virtual education there is an exchange of original ideas, information, and knowledge, and some of the actors may wish to publish them. For this reason, and from the beginning, it should be clear and respect individual efforts, and structure some form of recognition or appropriate reward for collaborative contributions.

   One way to respond to this challenge is to recognize the difference and relationship between the roles of the author as owner, and a material and technological understanding of the practices that give rise to the composition of the product. It is no secret that many teachers take students' ideas or products and make them their own; so the challenge for the teaching model is to establish how to reward or punish, authorship in interactive and collaborative work.

4. *Appropriate use*. Appropriate use of material and knowledge disseminated from different sources is a complicated issue in education because if clear rules are not defined institutionally in this regard, they may be used inappropriately, for example, by freely sharing copyrighted material, imparting non-validated knowledge or accepting work in which textual information is copied from other sources. The teaching model plays a key role here because it must be designed to respect intellectual property and give recognition to those who deserve it. Teachers and students should be aware that appropriating the knowledge of others is unethical, so they should learn how to do it without violating rights, openly disclose what is allowed and in the proper way, and know the penalties for doing the wrong thing.

The growing demand for a diversified education generates a challenge for institutions and professors to develop teaching strategies appropriate to the characteristics of students and teaching-learning environments. One way to respond to this is to structure and design a teaching model suitable for each educational scenario, whether traditional or virtual. However, there is little research on how to do this efficiently, and many of the published works are simply models experimenting with adaptations of one scenario to another. The reality is that each scenario is different, so more attention needs to be paid to this issue.

In the case of the teaching model for virtual education, it is not simply a matter of doing the same thing that has always been done in traditional education, because if it does not work in one, it will not work in the other. It is necessary to ensure that the quality of the student's learning experience is not diminished; to ensure that it is not simply an adaptation to the student's preferred learning

style, but that they expand their learning strategies and expose them to other viable and interesting ways of learning. In any case, the teaching model for virtual education should be researched, analyzed, debated, and simulated before exposing it to the students, because at that moment it should already be at the right point of design and oriented to the achievement of learning outcomes.

2.6 LEARNING MODEL

Learning theory aims to explain and help understand how people learn, but the related literature is extensive and complex for most stakeholders because it involves multiple disciplines and ideas that materialize in diverse theories, with followers and detractors around the world. As a product of the transdisciplinary integration of sociology, neuroscience, neurocognition, and education, among others, theories such as behaviorism, cognitivism, and social constructivism were developed and disseminated in traditional education. But with the emergence of virtual education, it has been difficult to find the basic theories that allow an adequate understanding of how the student learns in this educational modality, although some emerged from the most widely accepted learning theories.

It is a fact that virtual education plays an active role in the fulfillment of Article 26 of the Declaration of Human Rights, as it relates to the right of people to education and to develop their full potential. For Paulo Freire [54] knowledge emerges only through invention and reinvention, through the restless, impatient, continuous, and hopeful inquiry that people carry out in the world, with the world, and with each other. Therefore, the right to education must include more than just accessing information, but also using and sharing it, and questioning authority and what is perceived as truth. In addition, and relation to knowledge, the right to create and share it, and to modify and update it.

On the other hand, education in general is a continuous improvement of consciousness and an incessant sharpening of judgment and, if teaching can impart knowledge, learning leads to the understanding of things from reasoned judgments. Learning is neither a single path nor an end goal, for it is the motivating power by which people form and impose a character on their role in life. Through learning the approach to natural resources, science, and reason to select what is best suited to each situation and to develop capabilities to achieve goals.

In virtual education learning is oriented in this way, towards personal appropriation, and is known as self-directed learning, becoming a cornerstone for the design of virtual teaching-learning environments. Since the early 1970s researchers began to explore how students learn for life and found that they did so largely independently and autonomously, and have since taken this as a basis for developing learning models.

In virtual education, self-directed, independent, and lifelong learning is encouraged from the teaching model, learning processes, and learning outcomes. The reason is that in the New Age students, professionals and workers face high pressures to continuously update their knowledge and to develop skills that allow them to be up to date in their work and social situations.

In this way, a flexible and convenient learning model is structured that offers them opportunities to expand or update knowledge, with flexible access options to meet their needs, while respecting their multiple learning styles and individual differences. This facilitates the development of reflective and higher-order thinking because it takes advantage of recurrent media and technologies in the personal and professional life of each of them.

Self-directed learning seems simple and natural, but in reality, it is one of the most difficult practices to implement in education or people's lives, so they also need support and advice. Learning in virtual education is not always joyful or motivated by felt needs, because the learner, as a human being, may experience feelings of an *impostor*, in playing a role that does not represent who they are; of *cultural isolation*, in feeling excluded from their home culture; of *losing innocence*, in the sense of not appreciating absolute truth; of *incremental doubt*, in remaining anxious to close the gap between old and new thinking; and a *sense of disconnection*, in feeling socially isolated.

To help them with these doubts, the virtual teaching-learning environment should encourage dialogue and collaborative inquiry as a social glue to keep their individual learning experiences together. Furthermore, by fostering an open environment of dialogue and interaction focused on learning, rather than content, real learning takes place.

In an effective learning model, the meaning of dialogue is not found in any of the interested parties, but in the exchange, so it transcends subjective opinions and gives rise to participants waiting for what the other will offer. That is why the learning model in virtual education needs an adequate teaching model, in which teachers move away from pre-established *scripts* and deliver knowledge spontaneously and authentically, from their professional and personal experiences. This form of knowledge sharing forges greater trust between the parties and awakens their curiosity, interest, and desire to investigate what they do not know or do not understand. The point is that everyone has access to the same sources, but, in the dialogue, each one contributes the knowledge he or she has created or discovered on his or her own.

Another characteristic of this learning model is that there are no categorizations because all participants treat each other as equals, a prerequisite for true dialogue. In teaching-learning processes where the teacher *feels* superior, there is no dialogue, only passive agents who listen to the discourse, while losing confidence in the speaker, because he only seems to declaim what he has read, without any validation or experience. To focus on the subject matter, and not on underlying issues, a teaching-learning model is needed in which the actors are involved in the process to co-create the knowledge that allows them to achieve the learning outcomes.

In virtual education, and by engaging in true dialogue, learning is the main actor, because it emerges, is analyzed, and is shared through social relationships, respecting differences, and through harmonious learning processes. These processes are designed as meeting places where participants face challenges as they see them individually. Therefore, dialogue becomes an encounter between diverse people, where tensions between different levels of knowledge and understanding are the main factor that leads to the collective development of learning.

However, for a student to be successful in the virtual teaching-learning environment, he/she must evaluate the way he/she prefers to learn because in this environment the strengths and weaknesses of his/her learning style can have a strong impact on the achievement of the learning results. That is why the teacher must identify the student's learning styles so that together they can develop strategies that allow them to maximize their strengths and solve their weaknesses.

In the literature, it is found that the most researched learning styles are auditory, visual, and kinesthetic. In the former, students need to hear what is happening, so lectures are their main focus of learning; in the latter, they need to see or graph the concepts, so they take notes in lectures or draw diagrams and mind maps of the points they consider important; while kinesthetic

learners need to move physically to understand the concepts and build models to physically simulate the problem. Neither style is better than the other and students can use them interchangeably depending on the learning process, but they must define their preferred style to best achieve the learning outcomes.

Through an appropriate teaching model, virtual education generates environments in which students can take advantage of all these learning styles. Although it may be thought that this environment favors visual learners, a well-structured learning process, with innovative didactics and interactive dialogue, becomes a tool in which students need to read and interpret graphically and visually the contents to reach the necessary knowledge.

Students are aware that in virtual education they will listen to fewer lectures, so taking notes seems unnecessary, so they should plan how to learn. Below are some strategies that have proven to be efficient for this purpose, which the teacher should also be aware of and be attentive to help students:

1. *Organization*. It is convenient for people to have a previous idea of what they are going to learn. This organized way of entering into a learning process offers them the possibility of improving their understanding of the general concepts, so it is recommended that they research each topic before entering virtual education.

2. *Concentration*. Because virtual teaching-learning environments are offered on the Internet, the student may be tempted to do different things while attending the learning process, such as surfing, reading mail, or attending other online requests. In a virtual education environment, it is easy to get caught up in links on a topic and end up far away, so you have to stay focused on the learning objective.

3. *Selective attention*. Each learning process is made up of reading and references material, as well as didactics, research, presentation, and evaluation. To achieve better results, the student places his attention selectively on each of these components, that is, if it corresponds to reading, then he attends to that process, but if it corresponds to a presentation, then he is motivated to find out how to do it in the best way. In other words, students should not worry about developing the whole learning process at once.

4. *Permanent monitoring*. The basis of virtual education is autonomous work, so the student assumes the task of monitoring his progress in each learning process. Therefore, in the case of not understanding a topic or having problems performing an activity, he/she turns to the teacher or classmates to overcome the problem. An important characteristic is that the teacher can also notice the problem, although not physically, but by listening to his tone of voice, the value of his participation, or the comments of his classmates, and then look for ways to help him.

5. *Progressive advancement*. Learning is a process that should be taken calmly and assimilated the necessary knowledge to develop learning achievements. It is common for students to want to learn everything in an accelerated manner, but this generates inconveniences and often causes them to lose interest. That is why it is necessary to take everything calmly and to advance progressively until completing the learning process. One way to progressively advance in knowledge is to listen, discuss and clarify concepts with the teacher or classmates, expand the topic through comparative research, and not try to assimilate everything at once.

6. *Self-assessment*. Since challenge-based and project-based learning is the line of work in virtual education, students are immediately aware of their learning progress. To validate this progress, they meet with peers in work teams and review concepts, results, and levels of understanding. In addition, they consult the teacher when they do not reach conclusions satisfactory to all.

7. *Active breaks*. No person should spend all their time developing sequential activities in a field of action, because concentration levels tend to decline and results will not be the best; in addition, the body suffers. Education is no exception, so students take relaxation sessions and take time away from the learning process. To achieve increasingly comforting results, they must relax, do other activities and recharge their energies.

8. *Teamwork*. Although much of virtual education results in individual work and under the responsibility of each student, it cannot be the only line of work. There are also reasons to work with other people because the development of the project, the integration of learning, and the validation of what has been learned cannot be achieved only with individual work. Among many other things, teamwork allows for identifying additional ideas, perceiving improvements, identifying mistakes, finding ways to improve, improving understanding, improving achievement times, sharing thoughts and feelings, and developing skills and abilities for professional performance.

9. *Thinking Strategies*. Students learning styles should include the development of thinking strategies, such as learning to categorize concepts as they read or learn. This is related to the teaching model since it takes into account that, without the permanent presence of a teacher, the student is obliged to develop these strategies on his own. Therefore, the content of each learning process is organized to offer the student an order of thought. Of course, part of the learning process is developed individually, so the curriculum offers the student the tools to organize the concepts in a way that he/she can understand them.

10. *Reading strategies*. Since virtual education requires more reading, research, extension, and discussion of knowledge than traditional education, the student develops novel and effective reading strategies to achieve the learning outcomes. Some strategies are: 1) highlighting text that captures the essence of the concept or topic, 2) drawing outlines of the concepts in the mind, and 3) inferring knowledge based on what he knows about the world, how people think, write, and speak, and what he researches about the author of the material. But all this does not achieve the learning objective if the student does not have a good knowledge of the language in which the learning process takes place. For this, it is convenient that he/she knows the grammar, spelling, and syntax of that language, which will facilitate the reading.

11. *Writing strategies*. Just as you should develop strategies for reading, so should you develop strategies for writing, and note-taking or outlining is always a good strategy. Writing or summarizing what the student is studying stimulates thinking and learning, which is complemented by researching a little more about the topic he or she is writing about. Many students try to write down the main ideas of the reading or lecture, a strategy that serves as a source of reference to remember something in particular. But, as with reading, writing requires knowledge of the language in which the learning process takes place.

Each person has their style of gathering and organizing the knowledge they or needs to learn, and it is not possible to claim that one is better than another at studying in a virtual teaching-learning environment. For example, introverted people find it easier to communicate online than in face-

to-face situations, but an important advantage of virtual education is that the teaching model is less hierarchical than in traditional education, so it does not *discriminate against* those who are unfamiliar with technologies. On the other hand, learning environments in virtual education can develop the maximum potential of each person, because learning is collaborative and complements the individual learning style.

As already mentioned, students have developed one or more learning styles, or a combination of them, so the curriculum and teaching model must ensure activities that offer successful experiences. It should not be forgotten that learning styles serve individuals to understand themselves, so creating a learning environment in which they can identify themselves is key to the success and achievement of learning outcomes. It is important to keep in mind that even if a student learns best in a certain way, he or she must be exposed to a wide variety of learning experiences to become a versatile learner. Thus, if the teacher identifies the learning styles of the students from the beginning, he/she will be able to define a more appropriate learning context for the group.

One thing that virtual education is clear about is that each student has a unique and unlimited potential, a reality that is overlooked in traditional education. This also becomes a challenge that forces virtual teaching-learning environments to seek and explore possibilities to discover, develop or enhance that potential. In addition, teachers are obliged to identify the learning style of students, to guide them to maximize their potential, so virtual education uses collaborative learning as a tool to achieve this.

The characteristics of this learning are to explore, discover and experiment, and to maximize the potential of students, both teacher and peers become versatile and flexible *partners*, thus creating an environment conducive to learning in virtual education.

2.7 DIDACTICS

Amid technological development and global connectivity, teachers coexist between the palpable contradictions of the traditional education of the industrial model, based on the static culture of the printing press, the book, and competitive individualism, and the wide possibilities of collaborative learning, meaning creation and knowledge configuration of virtual education. Digital environments provide a new type of immediacy and access to information, interactively and without territorial limitations.

Moreover, in this divergent scenario, learning is not geographically tied to a desk, library, book, or teacher, so the old pedagogical model of transmission and surveillance is destabilized and becomes obsolete; the concept of singular literacy based on print is re-conceptualized as an environment in which the diversity of information sources to which people have access daily is re-acknowledged.

Influenced by the new learning theories arising from neurocognition, many educational researchers defend the need to revolutionize the teaching-learning processes. The basis of their claims is that mediated access and new relationships with knowledge have changed educational practices and generated new types of social relationships between people. In the old view, learning occurs in situated socio-cultural contexts, where it is the product of social interaction, dialogue, negotiation, and evaluation. Whereas in new thinking, learning and the exchange or production of knowledge originate in interactive communities, where students have access to diverse sources of information, modes of communication, and discussion groups.

On the other hand, challenge-based and project-based learning is more sensitive to students' previous experiences and knowledge and provides them with authentic learning experiences in which they develop and use transdisciplinary thinking. It is a tool that enhances collaborative learning and a powerful antidote to the transmissionist model where knowledge is a parceled object because it considers that acquiring it is a process in which learning is discussed and developed. This process implies and describes more adequately the intrinsic relational aspects of knowledge to achieve learning outcomes, because students apprehend, use, investigate or reproduce knowledge.

As humanity moves into the New Age, people are finding new and different ways to access information, which has profound ramifications for reading and writing, and although the fundamental principles of reading and writing have not changed, the serial cognitive processing of linear printed text has given way to the parallel multidimensional processing of multimedia information sources. On the other hand, text and meaning are no longer integrated exclusively in a linear sequence of alphabetic characters; instead, hypertext incorporates text-image-potential meaning in a pattern of links that readers can follow or ignore. This process demands a particular kind of reading, cognitive mapping, and navigation of routes radically different from what is experienced in the linearity of printed text.

Likewise, the new category of students lives in a world of connectivity and immediacy, of fun and games, without borders and without restrictions on access to what they want to learn, so entering an educational system that locks them in *boxes*, where the disciplined cognition of the task prevails and where individualism and the gratification of a grade are characteristic, generates an intense adaptive struggle for them. There they feel they are in another world, where teachers are like *aliens* from another era, trained in the 19th-century system and trained in the culture of the book, who consider themselves *experts* in a disciplinary content area and are afraid of new technologies. In addition, they consider that teachers see them as *digital alien beings*, who are always connected and who speak in a strange and incomprehensible language.

Connectivity allows people to enter a world without borders, an immaterial space where the sense of space challenges the traditionalist understanding of knowledge, place, and socialization, which the educational system considers fundamental to an educational experience, and which was the norm in which most teachers were trained and are struggling today to understand the New World Order. But, while the child is a savvy citizen of the digital age, for whom *real life* is online, adults log on sporadically and only to perform operational functions. In the New Age, information, ideas, cultures, and social relations intersect and flow in a global multimedia network, where most learners' experiences and knowledge of the world are shaped and defined, along with their identities, literacy practices, and learning.

About didactics, the curriculum of the Industrial Age education system is still based on the pedagogy of chalk, board, and tongue, and does not structure or validate learning outcomes, but rather on memorized academic competencies and results that reproduce isolated facts in discrete areas. In a well-structured virtual teaching-learning environment, the most important thing is the understanding of the relationships between ideas and their use in the development of projects. This way of looking at learning is based on the association and integration of knowledge, so it is a cognitive and socially situated repertoire similar to what people use in everyday life.

The educational system has gone through a process of ups and downs regarding the inclusion of technology as a teaching tool: first, it was thought necessary to have a computer in every classroom; then the idea was to place one on the desks of all students; later, it was sought to

connect all classrooms and to the global network; and in this century the effort is to plan the wireless institution. Due to the massification of video games in the console years, today we know that children developed social habits outside of school and that students of this century prefer to work around a screen in problem-solving and information exchange. This has been transposed to classroom education because they learn in fun scenarios that involve risks but at their own pace.

In the scenario of virtual education, didactics have to be thought of differently and adapted to achieve learning through collaborative work, developing at the same time the meta-awareness of students about their abilities and learning styles. Didactics in collaborative work must achieve the understanding of each student in the context of peers, but in a close relationship with and guided by the teacher. This is achieved through guided instructional conversations, in which there is no figure of a mediating authority or *expert*, because the achievement of learning is what attracts the group and helps to retake the course of the students, or suggests alternatives for change. That is why effective online learning encounters take place in real-time and synchronously.

But this should not reinforce the fear of many people that in virtual education the role of the teacher disappears because technology is just one more resource among the many didactic options that are developed in this educational environment. What happens is that the teacher's role changes from being the knowledge center for learning to a consultant with specialized expertise who deploys didactics to help students achieve the programmed learning outcomes through authentic and relevant activities.

The point is that this type of teacher must forget the ancestral tale in which didactics is the pedagogical pillar of education because this *pedagogy of instruction and immutable facts* has passed into history in this century. The teacher is no longer the authority, there are no right or wrong answers, the important thing is not that students sit still and listen quietly and attentively, and do not passively accept that the teacher is the one who knows and is an expert. Now the teacher advises students who are different, restless, who interrupt and resume the learning process, and whom many times in traditional education are classified as deficient or bored, unable to concentrate, and are misdiagnosed with learning disorders or disabilities. The teacher needs to use didactics in this new context because it depends on it that the learning processes provide the tools for students to achieve the established learning outcomes.

Today's students were born and developed amid the so-called Information Society, and they will perform professionally in the New Age. Their attention is focused on the plurality and abundance of information, so they expect didactics to provide them with the real possibility of accessing this information and productively generating knowledge. This is consistent with the need for continuous learning, independent of time, space, age, gender, or socio-cultural distances that today's society demands.

This means that the discovery and construction of knowledge take place not only through the student's cognitive patterns but also in their social interaction through processes of mediation, negotiation, and cognitive learning. Virtual teaching-learning environments went from being document centers to data centers with tools to process, aggregate, recreate, and share them collaboratively. Likewise, static learning evolved into dynamic online learning where it is developed interactively, and where knowledge is built based on shared interests and activities.

Educational activities in cyberspace are based on digital language, which makes it easier for the teacher to design a teaching model in which his didactics distribute words, sounds, and images at

any scale, making the learning process circulate and for students to assimilate and personalize it according to their identity. But these didactics, in which technological interfaces are used, cannot neglect the indispensable human mediation of access to knowledge.

Therefore, didactics in virtual education must be permeated by the marks of digital culture: flexibility, openness, interlocution, exchange, complexity, creation, and collaboration. In addition, it must go beyond seeking only results, because as an educational practice, it must integrate the processes, relationships, and exchanges established by the actors involved in the learning process.

In this sense, didactics in virtual education are: 1) *temporary*, because it arises from the memory and experience of the teacher throughout life, as a student and as a professional, from his experiences and feelings, and from the moments he lives in the school community; 2) *plural and heterogeneous* because it is the product of the personal, academic, experiential and didactic-academic culture of the teacher, which he uses to ensure the interaction and integration of students in a teaching-learning environment; 3) *personalized and situated* because the teacher is a being with his own physical and emotional characteristics, who advises a learning process in which other beings with equally differentiated characteristics participate.

The particularity of the Spatio-temporal dimension of the learning processes in virtual education requires that the teacher possesses skills and knowledge aimed at developing factors such as organization, correctness, disposition, cordiality, and sensitivity, necessary to create, use and maintain an environment conducive to learning.

The teaching profession is an activity that requires qualification and knowledge in the disciplinary and academic fields because, in addition to being a profession with high social responsibility, it involves training people and training professionals to capture, understand and comprehend information, in a permanent process of construction and use of knowledge. Thanks to the wide penetration of Information Technologies in teaching, teachers face new paradigms that affect the practice, didactics, processes, times, and spaces of education.

Access to these technologies also allows unprecedented interaction between people at different times and in different spaces, from which new ways of thinking and imparting learning processes emerge. Unlike traditional educational didactics, in this new educational scenario, teachers and students are expected to develop attitudes and skills to achieve the established learning outcomes. In addition, the teacher changes his role and acts as a mediator and advisor of the learning process, which requires additional knowledge of the discipline, directly related to the design and implementation of didactics specific to virtual education.

The following are some of the challenges faced by the teacher to make his or her didactics fit and be efficient in this context:

1. *Social interaction*. In virtual education, the actions and relationships between the actors involved in the education are different. Hence, the didactics are designed so that the teaching-learning process, as a social act, provides an adequate reception and interaction between the teacher and the students. Thus, both overcome the social interaction of traditional education, in which at the same time they occupy the space of the classroom, and get used to the physical absence in the virtual teaching-learning environment. The didactics, together with the teaching model and the curriculum, are thought and designed for virtual social interaction, and to prevent it from becoming an obstacle to the achievement of learning outcomes.

The lack of face-to-face contact cannot be a factor that destabilizes a learning process, so didactics is adjusted to an educational environment in which the body language elements of social interaction and oral and visual communication, characteristic of traditional education, are modified. The didactics of virtual education favor a teacher-student interaction in which the meanings expressed not only by verbal language but also by non-verbal ones, go unnoticed or are exploited in another way. Moreover, the teacher can perceive the students' needs and reactions to the learning process and immediately engages in mediation that responds to what he or she perceives.

To achieve this purpose and seek new interpersonal relationship references, the teacher understands that the virtual teaching-learning environment is a space whose objective is to form people and train professionals. Therefore, for students to achieve human and technical-scientific growth, it is necessary for the teacher to show love for what he/she does, and to welcome and motivate them to persist in virtual education, because it is a modality that demands new attitudes, such as autonomy, discipline, punctuality, and perseverance.

Although the space-time gap in the social interactions of virtual education can hinder the relationships and interactions between the teacher and the students, generating at the same time a false impression of coldness or sympathy between the parties, the rapprochement is facilitated by a pleasant and sincere coexistence. This is because contact is brought closer through dialogue and a closeness evidenced by the use of effective and informal language in seminars and written texts. Therefore, in this teaching-learning environment, the teacher builds a path that allows him/her to advise in a dialogical way, recognizing at the same time the personal, academic, experiential, and didactic-pedagogical culture that underlies each learning process.

In virtual teaching-learning environments, the teacher is obliged to design a teaching model that allows him/her to establish an authentic social bond with the students while considering ways to strengthen and maintain it because, in virtual education, social interaction and the sense of belonging are essential factors for the construction of knowledge.

2. *Language skills*. Among the parameters of interpersonal relationships and knowledge construction in virtual education, the reading and writing skills of the actors are an important reference, because, given the impossibility of physical contact, language defines and creates identity in people. Therefore, the way students express themselves in verbal or written language is a good way to individualize them, since they are psychosocial beings who imprint their identity in communication, just like the teacher.

   In the virtual education environment, the perception of the world that students have or develop is a preponderant factor in the quality and depth of what they read or write in the communication process. Hence the importance of the teacher using didactics that allow students to interact with the materials and contents in the learning process. It depends on this that they can construct a coherent representation of learning, activating previous knowledge to reach creative conclusions. But the teacher must also demonstrate adequate linguistic skills and be able to use them in groups to guide learning and mediate social relations.

3. *Multiculturalism*. In virtual education, characteristics such as rigidity, homogenization, and monologist are avoided, and flexible, decentralized, and interactive learning processes are generated. To achieve this, it recognizes the variable of the students' cultural profile, shaped by

age, gender, beliefs, territorial belonging, and language skills, among others. That is why the teacher needs to know the students beforehand and, based on this information, design the teaching model and didactics adequate to achieve the learning results, because students arrive at virtual education with different degrees of learning, knowledge, and culture, ...

The teacher also knows that how people relate to teaching and learning depends on their experience in the regional context, their cultural profile, or the educational modality they select. Then, knowing that they come from different geographic areas and socio-economic strata, the teacher has the advantage of knowing that students come to virtual education without being clear about how it differs from traditional education, and then act accordingly. That is to say, to design didactics that respect this cultural reality, which is in itself a way of getting to know them in terms of their way of being, relating to each other, living, and expressing themselves.

In a virtual teaching-learning environment, the teacher must know who his students are, what their needs are, and what their expectations are, and relate this knowledge to other characteristics necessary to carry out the learning processes. Among his didactics, the teacher develops means of organization and management, both in his teaching and administrative and counseling activities, so that his relationship with the group flows correctly and with punctuality and organization.

4. *Timely response*. In virtual education, both the teacher and the student learn to establish priorities, assessments, and routines to perform their roles. It is important that the teacher responds promptly to students' doubts or difficulties, reminds them of activity deadlines, and delivers the results of the learning verification and validation process on time. This avoids the accumulation of activities in the management of learning processes, which can delay or prevent learning results.

   It is important to consider the time factor in the elaboration and availability of the answers, because in this way the student feels listened to, is motivated to correct, or is happy to know that he/she did the activity well. As in traditional education, in virtual education, the student will always be anxious to know how he/she did, what mistakes he/she made or what his/her academic performance is, so the teacher plans the appropriate answers in each learning process. When this is established in the curriculum and the teaching model, the review process is facilitated for the teacher, the student stays motivated and the activities are developed with agility.

5. *Contents*. In a virtual teaching-learning environment, teachers are familiar with and master the technologies available to them to socialize the study material in each learning process. The tools that are frequently used are basic and complementary readings, represented in electronic texts, multimedia, and video conferences; in addition, some teachers elaborate their support material, such as videos, music, study outlines, and summaries, among others.

   In addition to the technologies, the teacher also knows the content and studies it before starting any learning process. If students know the material and have access to it, some of them will have the intention to go ahead or search on their own in other sources, which may leave the teacher's knowledge unsatisfactory if he does not do the same. Hence the importance of previously interacting with the available material and validating the theory and developments in each topic. The point is that information, from which knowledge is generated, flows in torrents on the network and students can access it very easily. Therefore, the teacher must go

one step ahead, or at least be at par, to participate in the dialogues and analyze with the group the contents, from which they will obtain knowledge in each discipline.

The teacher is a researcher in search of new ways and means to mediate learning because in virtual education he does not have the support of a physical board to show students what to do or how to improve. This academic mediation requires him/her to develop specific knowledge in terms of language, didactics, content, and organization, but also to know the platform where the teaching-learning process takes place.

6. *Learning outcomes*. Regardless of the modality in which it is developed, in any learning process, the teacher is the main responsible for advising the student to achieve the results. But in virtual education, and given that mediation with students takes place in different moments and spaces, it is necessary for the teacher to be creative in his didactics so that students do not feel alone and to keep them motivated.

   To meet this challenge, in addition to being a receptive and sensitive partner, he/she associates knowledge to intervene when he/she detects that the student has difficulties that interfere with the achievement of learning outcomes. By mediating student interactions and manifestations, the teacher has sufficient information to channel an intervention and get them to understand and overcome the weaknesses that hinder their learning.

Getting students to achieve the established learning outcomes is a challenge for teachers because they must go beyond simply answering questions or pointing out deficiencies. The teacher identifies and intervenes in students' difficulties and advises them on how to reconcile personal and professional life with academic life because if they are not aware of this they put their learning process at risk. It is not a question of him acting as a psychologist or transcending his academic responsibilities, but given that he is the one who has first-hand knowledge of each situation, he has to be the first to intervene, as far as possible or as far as the student allows him to do so. In this sense, teacher mediation allows students to study with flexibility, discipline, initiative, dialogue, and collaboration.

2.8 VERIFICATION AND VALIDATION OF LEARNING

Although in traditional education it is generally thought that the only way to know if the student achieves the learning results is through evaluation or, better said, through standardized tests, the New World Order demonstrates that, for an adequate professional practice, the person requires much more than simply memorizing information and obtaining a grade. In this century a person demonstrates that he or she has learned only when he or she understands and comprehends the knowledge surrounding a discipline. In this statement the term *understand* refers to being able to describe or define the acquired knowledge with his words, while *understand* is related to being able to use it to solve real-life situations. Therefore, the evaluation of the achievement of learning results is different, so in virtual education, the memoiristic test is left aside and a process of *verification* and *validation* is structured through projects.

The process of Verification and Validation arose in Computer Science, specifically to check and ensure that the software is developed according to the specification and that it meets the customer's needs. But in assessment, they are used to check and ensure that students develop knowledge in response to the teaching model and didactics and that they achieve the stated learning outcomes.

From this point of view, the term Verification refers to the action of *checking that what we say we are doing to generate knowledge, we are really doing*; while Validation refers to *confirming that what we are doing to achieve the learning outcomes, we are really doing it well.*

If institutions and teachers plan and carry out an assessment as a project in which learning is seen as the most important thing for life, not only for students but also for society, then the distance between verification and validation is reduced, while increasing the chances of achieving learning outcomes. This has a direct relationship with the challenges in the New Age in terms of skills, abilities, and capabilities that people must develop, so there is a need to rethink and reorient assessment.

Although teachers have always assessed students using a wide variety of methods, such as interviews, written tests, oral presentations, practical application, and exposure, assessment is often given little importance when designing the curriculum. This occurs because institutions and faculty fail to identify a direct relationship between the teaching model and learning outcomes, leaving the assessment process to the inventiveness of the moment. One way to approach this relationship is to: 1) design a direct correspondence between learning achievement, teaching model, and didactics; 2) use diverse data sources to create as complete a map as possible of each learning process; and 3) remember that not all learning outcomes are directly and accurately verified and validated.

For evaluation in virtual education, it is key to use collaboration and social construction of knowledge and to encourage cooperation and creation among peers through the development of dynamic, active, and constantly changing projects. But this paradigm of information exchange *scares* traditionalist teachers because they feel they *lose control* over learning and do not accept that in today's education they have to learn to:

1. *Sharing control*. One of the aspects that teachers find most difficult in virtual education is that they cannot physically see the students. In traditional education they control the classroom and the environment, they observe the students face-to-face and, therefore, control the evaluation. For example, in an oral presentation made by a student on a specific topic, the teacher evaluates criteria such as articulation, presence, body language, ability to answer questions, and control of the audience. This is impossible in a virtual teaching-learning environment.

   But it is not so complicated, what happens is that the teacher has to share control, something that demands trust in the teaching model and the didactics used, as well as in the student's ability to learn. This requires that the syllabus and contents present the knowledge base that the student needs to make a good presentation; that the student has the opportunity to check it; that the student knows the criteria under which he/she will be evaluated; that peers can evaluate him/her on their own; and organize a discussion group to analyze the results and reflect on what went well and what could be improved, and allow him/her to make the presentation again. In this case, by verifying and validating knowledge in a shared way:

   - The student acquires the responsibility to learn and evaluate.
   - The student learns to use the resources for continuous assessment.
   - A real-world environment is reflected in the evaluation.
   - Students develop thinking skills related to application, analysis, synthesis, and evaluation.
   - Assessment recognizes that learning is important for life, and provides the student with a fair reflection of the learning outcome.

2. *Re-evaluate evaluation*. Since educational institutions and faculties still do not envision the need to train and qualify teachers for virtual education, and most are still convinced that teaching in this environment is the same as in traditional education, many teachers are sure that the best way to evaluate in virtuality is to apply the so-called *objective tests*, i.e. multiple choice, true/false, fill in the blanks, etc. This type of test is not recommended in any educational modality, because they completely ignore the learning model and style of the students.

   But they are easy to review and grade, although for the student they do not represent a real challenge to overcome to know the level of knowledge development, since the only thing these tests measure is their ability to memorize. Furthermore, in traditional education, curricula determine the location of the test in the learning process, i.e., episodic tests that seek to homogenize students' abilities at a given moment. Thus ignoring that learning is a complex process, which encompasses both what the student knows (verification) and what he/she can do with the knowledge (validation).

   In virtual education, evaluation is re-evaluated and the methods and techniques used are innovated, the process moves away from quantitative evaluation and gives weight to qualitative evaluation, whether through integrative projects, portfolios, or performance observations. But it also includes more complex assessment activities, such as gathering information on higher-order thinking skills, affective development, professional skills, or civic-social activities.

3. *Practical applications of knowledge*. Education is structured around two basic concepts: on the one hand, learning theory and, on the other hand, applying knowledge in practice; that is, understanding and comprehending. Virtual education is an environment in which learning is relevant to the student because it offers the opportunity to experience knowledge in the real world. When the teacher shares control, he induces the student to apply the knowledge in his environment, and then share his experience with his peers. In this way, the student develops and uses skills such as application, analysis, and synthesis, while acquiring learning for life, while the teacher collects information to take into account in the verification and validation of learning.

4. *Project-based assessment*. This type of evaluation requires the student to synthesize, evaluate and prioritize different concepts before applying them to a project. The teacher observes the gradual development and identifies possible gaps in the process while inducing teamwork, in which the complementation of learning among the members is materialized.

   In general terms, challenge-based and project-based learning is a student-driven and teacher-facilitated approach [3]. The former want to learn by asking questions about issues that arouse their curiosity, so their choice is a key element in this approach, and teachers monitor each step of the process and discuss with students each option before making a search decision. In addition, students with similar concerns are organized to work cooperatively, encouraging the development of collaborative and communication skills, but respecting individual learning patterns and preferences.

   Because the inquiries are science-based or originate from social problems, reading, writing, interpretation, and application activities are included in the development, resulting in better understanding, deeper learning, higher-level reading, and increased motivation for learning, which is the basis for project-based assessment. In addition, it offers the teacher the opportunity to verify the development of critical and independent thinking skills because students solve real-world problems.

5. *Identify acquired knowledge*. In traditional education, more attention is paid to doing, demonstrating, and creating, almost completely ignoring reflection, patient waiting, and quiet moments. While many students prefer to take the necessary time to reflect on knowledge, because in this way they internalize, understand, and comprehend it, teachers mistakenly consider that this is not necessary, because they see learning as a static moment of education, and not as an element that directs the student's life. So, they strive to *cram them* with more information.

   Fortunately, students are not empty vessels waiting for the teacher to fill them with knowledge, but their minds already possess all kinds of important information, albeit with special needs and many distractions. Moreover, like anyone else in this century, they have busy lives and therefore need time to satisfy immediate learning needs, but also to try to clarify every step of their lives. In the verification and validation of acquired knowledge, students feel compelled to reflect on learning, while providing the teacher with information to identify the knowledge they understand and comprehend.

In this way, the verification and validation of learning are structured as a process in which the teacher gathers data and information that allow him/her to identify the assimilation, achievement, and impact of the learning outcomes while discovering the problems that each student may present. Because assessment is comprehensive, the process involves finding answers to the following questions related to students:

- Did they achieve the established learning outcomes?
- Did they achieve any different learning outcomes?
- How did you change your practice with the knowledge gained?
- What is the efficiency and effectiveness of the teaching model and didactics?
- How effective were the curriculum, content, and learning processes?
- What is the impact of the virtual teaching-learning environment on the results?
- What went wrong?
- What needs to be improved?
- What should be done differently?

The responses provide valuable information in the form of formative assessment as a continuous activity that occurs at any time during the learning process, which helps to identify problems in the material or shortcomings in the student's understanding and comprehension. With that information, the teacher can change the didactics, because the learning process does not seem to be progressing according to the curriculum. The point is that most institutions prefer to apply *summative* evaluation, that is, a measure of the student's satisfaction with the learning process and the teacher, and not of the dynamics and learning rhythms of the students themselves. In contrast, verifying and validating identify how students experience learning, and their concerns and expectations.

In virtual education, evaluation is established on a process of collaboration and transformation, to determine to what extent teachers facilitate reflection on the material, student participation, and analysis of the teaching model and didactics (verification), but also to determine how well students achieved the learning outcomes (validation). This is in line with the premise that students develop knowledge as they experience each learning process, so that is how it should be evaluated, and not as many think that they only achieve learning at the end of a topic, a learning process, or a course, when they answer the single standardized test.

Based on this recognition, and given that virtual education works with a student-centered approach, verification and validation are part of the teaching process, integrated into the learning processes and in the interactions among students, and between them and the teacher. This is facilitated when the teacher designs the teaching model, didactics, and learning outcomes with quality criteria. Furthermore, in the development of learning processes, more than knowledge in the content area is evaluated, because the teaching model must teach them to *think*, that is, to develop in them critical thinking skills so that they can apply what they have learned in other contexts.

In virtual education, evaluation is closely linked to and immersed in the design of the curriculum, the teaching model, the didactics, and the contents. That is, it must be aligned with the context of the learning process and with the learning outcomes that students are expected to achieve, as well as being adapted to the didactics and activities in which they participate. Using authentic assessments or real-life simulations helps to achieve this alignment because it directly addresses what is expected at the end of a learning process.

Verification and validation of learning are not separate tasks and should not be seen as cumbersome, but are part of and flow from the activities of the learning process. In this way, the student is motivated and interested, because he/she lives a learning experience in which he/she significantly increases his/her knowledge and knows what to do with it.

In the same vein, as the Information Society advances and the New World Order environment develops, knowledge becomes one of the most important assets for humanity. As a dimension of the New Age, the education system is called upon to plan how to verify and validate learning, because the universe of data on which learning processes are developed is such that it is necessary to select only those that truly help to form people and train professionals and to fulfill the requirements of social responsibility of the State about education.

2.9 LABORATORIES

While in traditional education it is increasingly difficult and costly to implement coherent laboratories to develop teaching and research, in virtual education, thanks to accelerated technological developments, institutions design and implement virtual teaching-learning environments with laboratories that incorporate new technological tools, where students approach the study of science and technology in a natural, comprehensive, playful, holistic, systemic and systematic way.

This cannot be a matter of just implementing laboratories, because it requires a methodology to design, implement, update and maintain them over time, which guarantees their operation and use by professors and students. This methodology allows institutions to structure laboratories in any area of knowledge, especially those with high-level practical and research components.

At any level of education, students need new and challenging learning environments to truly experience knowledge, without the fear of making mistakes that may cause accidents, with the known consequences of injury or damage, or the waste of expensive materials. In virtual education, it is possible to respond to this demand and get students motivated to experiment in any area because the laboratories are designed for them to have immersive experiences in virtual reality, where they apply the knowledge without fear and with the same experimental results of real reality.

The implementation of virtual laboratories creates an opportunity to stimulate students, through the use of technology and a context in which they speak the same language, to achieve greater knowledge and responsibility by taking ownership of their training process and applying it in experimental activities. In addition, they have the advantage that they can perform the practices from anywhere, at their own pace and using tools that are within their reach and under their control, but also that they can repeat the experiment as many times as necessary to validate the theory.

An important issue to be taken into account in the design of virtual laboratories is related to the social interaction in them, so it is necessary to apply some foresight and analyze specific issues that contribute to avoiding unnecessary disturbances in the work of students, such as intercultural differences, that participants feel out of place, or that those with high cultural status are privileged. In addition, since the experiments are part of each team project, students need to find a common schedule for practice; it should also be taken into account that some have easier access to technology or have cognitive difficulties in doing virtual work compared to face-to-face; and that working in virtual laboratories requires maintaining a demanding continuity of perspectives and ideas, working synchronously with others.

This diversity can be considered an advantage of working in virtual laboratories, although it implies considerable efforts to achieve good interpersonal communication. In fact, before starting laboratory projects, the teacher needs to work hard on the realization of interpersonal interactions, so that students become familiar with their peers and with their respective frames of reference.

On the other hand, virtual laboratories must function by respecting the concepts, demands, and needs of students at any level of training, while maintaining constant technological development. This is an aspect to be enhanced for the benefit of the achievement of learning results, as well as for the teaching model because teachers can diversify their didactics and achieve greater geographical and cultural coverage. When using tools that are relatively easy to access, it is necessary to be familiar with their use and the team must work at the same pace.

The virtual laboratory is an electronic workspace designed for collaboration and experimentation at a distance, with the objective of the research or creative activities and the elaboration and dissemination of results using Information Technologies. The virtual laboratory focuses on achieving creative learning outcomes and assisting in informed decision-making; it opens up new perspectives that are not possible to fully explore at a reasonable cost in the real world. In addition, the virtual lab is a borderless center where students experiment and research regardless of location, interact with others, have access to instruments, share data and resources, and access libraries anywhere in the world.

The fundamental support for these environments are computer programs and platforms, in which students work collaboratively and simultaneously; they share portfolios of annotations, electronic resources, videoconferences, and other tools with which they increase the feeling of sharing the same space in which they acquire and validate knowledge. As a system that allows interactive modeling of places, objects, or situations for experimentation, research, or observation purposes, these laboratories contribute to increasing knowledge and help students achieve the established learning outcomes. Among others, virtual laboratories have the following advantages:

- They allow students to discover or validate knowledge in terms of their experience in understanding experimental situations.

- They use tools that students need for their professional performance.
- They promote the development of logic and the ability to experiment.
- They encourage joint participation and remote collaboration.
- They allow each work team to advance at its own pace.
- They promote and develop new forms of individual and joint visualization.
- They allow the dynamic and interactive re-creation and study of existing, past, or future structures and projects under controlled conditions.

On the other hand, from the perspective of virtual education, the reasons for implementing virtual laboratories can be summarized as follows:

1. Because the verification and validation of knowledge are done through projects and, by focusing the laboratory on a project, the defined learning outcomes are better achieved, and the intellectual or creative collaboration, assimilable to a formal research process, is made concrete.

2. Students may want to modify the project by adding considerations that make it broad and complicated, but achievable, then they require specialized knowledge, usually focused on agencies that do not share it, and need to execute transdisciplinary cooperation actions that lead them to the search for what they require.

3. The general actions of interaction among students are facilitated with a virtual laboratory because it allows the formation of work teams, the definition of linked projects, and the joint efforts in the search for resources; when the project is executed in a team with members from different geographical locations, cultures, and disciplines, it is more likely to achieve learning achievements and technical knowledge.

More generally, virtual laboratories determine distributed creative efforts, because students contribute, from their different cultural perspectives to the development of each project. Looking at virtual labs from the teacher's point of view, several factors support them:

1. There are major technological and scientific problems with requirements that exceed the installed capacity of any physical laboratory.

2. The institutions distribute the human resource coverage and specialized knowledge required to achieve the projects' objectives.

3. By the themes of the learning processes, there is still a need for specialists from different regions to participate, providing specific data, evidence on an experiment, and human resources, among others.

4. An experiment may require access to unique, scarce, or difficult-to-obtain scientific instruments, such as particle accelerators, telescopes, deep-sea or space probes, electron microscopes, or high-tech analytical instruments, so the option is to simulate most of their functions using appropriate technologies.

5. Gaining knowledge and learning from the research results depends on the integral participation of the students in the project. This factor becomes important if the results need to be interpreted in a shared way.

Likewise, virtual laboratories enhance a new culture in science and education, because they share cognitive functions that produce unpredictable breakthroughs. Accordingly, virtual laboratories are particularly valuable for working in transdisciplinary teams, international or national, in prospecting and extracting data, seeking new correlations in data, finding new transdisciplinary and multicultural approaches to problem-solving, conducting joint studies in areas that require scientific consensus, and sharing a space where many students can experiment on the same problem to find a joint solution.

They are also important for education because among the challenges to be solved in this century is the need to structure and implement curricula oriented to develop people's skills, capacities, and abilities that enable them to be up-to-date and professionally current, capable of analyzing problematic situations in their area of training and making decisions to solve them; this demands exercising the principle of sharing resources and knowledge through collaborative, challenge-based and project-based learning, where laboratories are an important tool.

The experience accumulated in the different initiatives for the improvement of education has left important conclusions about how to train and empower people to achieve learning results. That is why virtual laboratories are a useful technique in learning processes because they are a means that facilitates knowledge from experimentation and participation, at the time and place that is most convenient for students, in addition, they repeat each experiment as many times as required, without being forced to physically move to an institution and at a certain time.

Among the many activities that a virtual laboratory allows to develop are: observing a diversity of phenomena, performing simple observation processes (unlikely to be seen in nature) by recreating or accelerating time in those that require long periods of observation, detecting phenomena that are not physically observed and simulating behavioral models, among others. It is also a fundamental tool when it comes to training for research because it allows the exchange of information and data from experiments to avoid repeating processes.

On the other hand, in this century, education researchers underline the challenge faced by teachers to *convince* students about a theory, because they are skeptical and feel the need to validate everything. Hence the importance of designing and implementing virtual laboratories in which they develop practices to understand, evaluate and promote knowledge while achieving learning outcomes in an experiential way. Furthermore, cognitive functions in virtual education are mediated by tools and artifacts that embody, expand and combine students' capabilities, so technologies are considered *cognitive artifacts* capable of supporting, guiding, and extending students' thinking.

This assertion is based on the fact that virtual laboratories do not facilitate tasks, but rather, when well used, they favor the construction and learning of meanings, which helps people develop critical thinking. In this scenario, laboratories acquire an important role, because they demonstrate that the construction and programming of experiments, as well as the simulation of theoretical behaviors, help students to achieve advanced learning outcomes, which enable them to solve problems in real life and to use thinking strategies to acquire new knowledge.

In general terms, virtual laboratories are configured as learning environments where: 1) students carry out activities aimed at acquiring and sharing knowledge, and 2) collaborative work and reflection are encouraged. Given the practical approach needed to educate and train people who

will be professionals in the New Era, these spaces promote student creativity and facilitate the teacher's integration of practices into the teaching model.

Since the educational approach of virtual education is project-based learning, which is characterized by cooperative and individual activities focused on creating, discovering, using, and disseminating knowledge, the virtual laboratory becomes a space where *doing* and *building* for learning take place. The teacher designs a teaching model and didactics so that, in the learning processes, students strive to find answers and solve challenging problems.

Practical activities enhance the self-learning experience and encourage the sharing of ideas and the development of knowledge through exchange and discussion. The teacher monitors the work of the students, who are encouraged to submit reports with important detailed descriptions of the decision-making and strategies they apply to carry out each practice. This allows the teacher to analyze learning progress from the structured activities to experiment in the laboratory.

2.10 CHALLENGES OF VIRTUAL EDUCATION

In the New Era, virtual education is established as the mainstream of modern education, offering learning resources and providing an effective meeting place for interaction between teachers and students; in addition, this type of education is consolidated as a formal form of learning, without the traditional restrictions of the classroom. In this space, and as part of their learning activities, students have access to an environment rich in interactive courses and multimedia channels that provide them with interaction and quick and convincing feedback, making their learning process take place in an active environment.

With the emergence of this current, the characteristics of traditional education became more evident, which make it deficient to achieve learning in the New World Order and for the students of the time. Most notably, being a one-to-many, static, and teacher-centered learning process, traditional education does not take advantage of the context and does not respond to the social needs of innovative professionals. It is noted then that the necessary and sufficient conditions for effective learning are those with a high degree of interactivity, student-centered, and with a many-to-many relationship. In addition, virtual education offers borderless access to the educational system, contrary to the physical limitations of the traditional.

But virtual education is not just a matter of knowing how to surf the Internet and, although it is a more advanced and structured process, the differences in education systems around the world mean that it is only in this century that it is being seen as universal. To achieve this, it is necessary to analyze issues such as access to technology, personal attitude towards education, the personal characteristics of students and teachers, the massification of the offer of totally virtual programs, and the improvement of virtual teaching-learning environments.

Therefore, before choosing virtual education as a development option, it is necessary to identify the various factors on which it is structured and which have cultural, technological, or environmental influences that will facilitate or hinder the choice. Let us analyze some of these factors:

1. *Space limitations*. This factor is most obvious in geographically constrained cities, where most institutions are located in small spaces with no room for expansion. This limits intentions to innovate or expand offerings while managing a remote site is costly because it results in redundant facilities and staff. In addition, students do not have the means or the time to reach

them, so to expand their physical capabilities the option is virtual education. But this implies a new way of seeing and managing education because a different teaching model than the traditional one has to be adopted.

2. *Ease of access*. The convenience of studying anywhere anytime offers people relief and flexibility amid their multiple occupations.

3. *Emerging sectors*. The first decades of the century demonstrated the value of lifelong learning, driving increased demand for education services in a population group that, in traditional education, was considered out of reach. Virtual education offers professionals and all types of employees the opportunity to re-skill and develop the skills and capabilities to respond to the momentum of business in the New Age. The goal of this emerging market is to invest in education and prepare for the performance of their functions or to participate in new opportunities.

4. *Insufficient resources*. Public funding for education has been decreasing over time, while virtual education becomes a less costly option for institutions, operates with a greater expectation of recovery, and, in addition to offering local and national coverage, has the possibility of reaching students in any geographic location.

5. *Maturity of technologies*. Technologies for designing, structuring, and implementing virtual teaching-learning environments are in constant development. Although there is sufficient supply to meet the current demand, it is expected that in the coming decades, the needs will change and that these technologies will evolve to the same extent.

6. *Access to technologies*. One of the main requirements for virtual education to achieve its objective of coverage, quality, and learning results is to have the sufficient technological infrastructure to develop and offer learning processes. That is why governments invest in this aspect and offer high broadband service coverage while motivating and, in many cases, subsidizing its adoption. But one of the most serious problems facing virtual education, especially in poor countries, is the lack of purchasing power to acquire the means to connect to the network, an issue that should be present in the plans of every government.

7. *Knowledge to take advantage of technologies*. Virtual education is a development that is offered on technological developments, so the student is expected to have sufficient knowledge to take advantage of technologies in their education and training. In addition, since the teaching model is innovative, it must also develop basic skills for distributed learning. This also extends to teachers, who must have good experience and control of the technology, design interactive teaching models, and encourage interaction among and with students. Since virtual education focuses on students, they need to be motivated and engaged, so a good practice is to take advantage of interactivity. When students are properly motivated they take advantage of additional learning opportunities and benefit from the educational resources made available to them. But this is not enough, because the teaching attitude of the teacher can greatly influence the learning attitude of the student.

8. *Geographic space*. In relatively small cities, students have few problems attending traditional institutions, but in those where transportation is poor and distances are long, it is not easy for them to travel to the place of study. This is why they turn to virtual education, as the offer of expanded education and ubiquitous learning allows them to study where, when, and how it is easiest for them.

9. *Living environment*. For a student to stay motivated, he must live in an environment that provides him with the conditions conducive to studying, but if his living environment is noisy and full of distractions, then he will choose to study in a traditional environment.

10. *Infrastructure*. Quality virtual education requires adequate bandwidth to achieve sufficiently fast multimedia communication. A deficient telecommunications infrastructure becomes a difficulty in the implementation of virtual teaching-learning environments. A robust infrastructure is key for the development of synchronous and asynchronous communications, and for the efficient exchange of text, graphics, audio, and video, which is a sophisticated means of interactivity that, in turn, generate motivation in students.

11. *Ingrained habits*. Moving from the traditional education model to virtual education requires a cultural change in students, teachers, administrators, and society in general. There is no denying that people have ingrained habits that are difficult to get rid of, but those who were born in this century have the advantage of living in a world of permanent change, so adapting to the virtual education environment is not so complicated. For others, it is necessary to offer an added value that they cannot find in traditional education, and that is precisely the ubiquity of learning. In addition, one of the difficulties to overcome in traditional institutions, which are immersed in virtuality, is to convince traditional teachers, because they will resist change.

12. *Purchasing power*. One of the characteristics of traditional education is that in many countries it is subsidized by the State, making tuition affordable for low-income people. The values of education become a problem when people want to enter virtual education, because, in addition to paying the tuition, they are obliged to acquire the technology and create the necessary environment to enjoy their learning.

13. *Quality of study material*. It is common for many traditional institutions to try to incorporate in virtual education the same material they use in face-to-face learning processes, but this will not work for them. Uploading flat texts, presentations and static files in any format is not what a virtual student expects, because many decided to switch to this model precisely because they were disappointed with the traditional teaching model. First, you have to design a quality virtual teaching-learning environment, and then develop interactive, up-to-date support material that helps to develop learning outcomes.

Although these factors have an impact on the implementation or not of virtual education, it is clear that they are not insurmountable and that, with the real will of all the actors, it is possible to design and structure a virtual offer in which students are formed as individuals and trained as professionals. This is a task that cannot be carried out in isolation, since virtual education is multidimensional and transdisciplinary and, therefore, efforts, experiences, and wills must be pooled to respond to the demands, needs, and expectations of students, companies, and society in the New Era.

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3. VIRTUAL TEACHING-LEARNING ENVIRONMENTS

In the 21st century, the web has gone from a simple platform to a complex platform, where application development evolves to offer people all kinds of services. Among these services is virtual education which, by aligning itself with revolutionary educational theories, is structured as an *intelligent tool* for the development of teaching-learning processes, through systems in which it is as easy to share what is known or thought as it is to learn. what others know.

Parallel to these technological developments, science reveals frameworks that allow understanding their impact on cognition, specifically on how people learn. And although in traditional education learning scenarios are still designed in which conventional forms of teaching are replicated for the transfer of knowledge, in these new scenarios the most important thing is the creation, discovery, and invention of knowledge. These environments encourage people to experiment and simulate all possible alternatives to solve any problem to learn.

In virtual teaching-learning environments, the relationships between the study plans, the teachers, and the students are developed in a distributed and collaborative way, so that the learning and knowledge processes are not restricted to the head of a single individual. This fits with the insight of neurocognition, in the sense that cognitive processes are distributed among the mind, artifacts, groups, space, and time. In addition, educational practice has shown that the mental load of learning spreads physically, socially, and symbolically between people and the tools they use in their training process.

A central aspect of education in these environments is that they structure contexts in which knowledge is seen as a phenomenon that occurs in the learning process, but that it is created and distributed with the participation of all the actors involved; furthermore, it is not considered as an entity independent of the activities and cultures in which it exists and develops. Therefore, learning in the environment is a contextualized activity, not an abstraction, which is reciprocally constructed based on interaction.

Faced with this innovation of seeing and accepting knowledge, the student changes his expectations about what he should know and what he should be able to do, while the teacher modifies the standards with which he *judges* the student's progress, as well as the way in that it verifies and validates the achievement of learning outcomes. A virtual teaching-learning environment is conceived as an educational innovation based on technology, which revolutionizes what and how students learn, and what, how, and when teachers teach. The reason why teaching and knowledge are revolutionized in these environments is that they are designed to take advantage of aspects of learning that are difficult to find in the traditional education environment; they use a teaching model that enhances the situated and distributed nature of cognition; and because virtual laboratories recreate learning situations that are not possible in real reality.

In this order of ideas, the virtual teaching-learning environment is a space where: 1) knowledge *circulates*, because all the actors have it, 2) knowledge is *shared* because everyone learns to learn, 3) learning results are *achieved,* because knowledge is discovered, created and distributed for real purposes, and 4) the space of the learning environment is *expanded* because it provides opportunities to expand the imagination of teachers and students alike. Furthermore, it resembles architecturally sophisticated buildings, where the teaching model shifts effortlessly between instruction, feedback, sharing, evaluation, and monitoring.

When properly designed, the virtual environment is both an elegant space for teaching and learning, and a place where students and teachers feel comfortable and motivated, because together they achieve learning results for life. But it should not be seen as an a-social space that can replace real reality, but rather as an innovation in which the social space of education is exalted; the possibilities to discover, analyze and share knowledge are improved; and access to a huge amount of resources is offered, which participants can analyze while attending a learning process.

The virtual teaching-learning environment is not a simple website, but a built information space, although many institutions structure it as a limited collection of HTML files, that is, a site with information architecture, not a place where *structure* or *organize* that information. This information architecture must respond to numerous functional requirements:

1. *Facilitate the use of information through dynamic interactions*. To achieve this, data and information are stored in dynamic structures or HTML files enriched with meta-information.

2. *Respect authorship and property*. Because the information stored in the structures is generated through transdisciplinary work, where people share, analyze, discuss and contribute, therefore, before sharing the information, it must be clear who will be the author or owner.

3. *Indicate and recognized sources*. When the information does not offer the data of origin, its value and credibility are questioned.

4. *Facilitate maintenance*. When the structures in which the information is stored grow, its administration can be lost, therefore, the environment must be carefully structured to maintain links and add or remove information.

5. *Stay current*. The effort dedicated to designing, developing, implementing, and maintaining a virtual environment is extensive, so it must survive technological developments, innovations, and the passage of time, and be easy to adapt to new contexts through innovations.

6. *Provide the exchange*. Students and teachers update their knowledge to the same extent that they share it, therefore, virtual environments should promote different ways to share and exchange knowledge. In this way, the contents will be updated and the analyzes can be carried out on issues that offer an adequate level of acceptance.

In addition to these functional requirements, in the different definitions for virtual teaching-learning environments, the element of communication is placed as an unavoidable capacity in them, but the main documented benefits are that it provides access to materials and resources, in flexible environments, in terms of access to knowledge and learning opportunities. But it is necessary to take into account some characteristics and principles that configure them as basic tools for virtual education.

It should be remembered that in the last decades of the 20th century, education privileged constructivist methods over any approach, particularly behaviorism, but with the appearance of computers, the educational theory was somewhat revolutionized and a social turn was given. towards the cognitivist, constructivist, and social constructivist perspectives. With the emergence of a strong web supported by stable technological developments, in the 21st century, an emerging work examining web-based learning begins, using constructivist frameworks to evaluate virtual technologies and environments for teaching and learning. learning.

This task has not been easy, because in traditional education the behaviorist theory still predominates, in which learning is seen as a conditioned response to a stimulus, which generates an observable change in people. Therefore, it is a transmission-oriented approach, with an emphasis on memorization, tests, and reward or punishment reflected in a grade. Added to this is the reality that many teachers are, in themselves, learners of behaviorism, so they do not easily accept virtual teaching-learning environments as places to teach, because they lose the power and prominence acquired over decades.

But these teachers are wrong because what is expected is that they update the concepts of educational theories. After all, they accept that cognition is how the student processes information and that, to achieve learning results, it must take into account how knowledge is built and developed from it. In virtual environments, learning is an active process through which students construct meaning, because they create, discover, and share knowledge, without a dominant figure that hinders their cognition. The success of these environments lies in the fact that the curriculum in virtual education focuses, on the one hand, on the construction of knowledge by the student and, on the other hand, on the construction of knowledge in social environments and through activities. social.

This makes it necessary to innovate the study plan, the teaching model, the didactics, the contents, and the learning model, for which greater participation of teachers is required in the design and evaluation of each program from a position criticism. But without falling into the behavioral error of thinking that the computer takes the place of the teacher because it is only one of the many tools that are used to establish interactive communication between the student and expanded education.

That is why the study plan must be developed in a conversational framework, in which the learning processes, the contents, the teaching model, the didactics, the learning results, and their verification and validation are planned. By structuring it in this way, the student is provided with an educational framework in which knowledge is discussed, not a space in which knowledge is imposed, and in this way, he understands and understands it.

In virtual teaching-learning environments, dialogue and the co-construction of knowledge are encouraged and experienced. That is why what many teachers affirm is not true, in the sense that in virtual education students are left alone and do not socialize with the teacher or with their classmates, because the study material is delivered in virtual texts and without a synchronous contact to analyze the doubts. The reality is that well-designed virtual environments are spaces in which knowledge is dialogued, shared, and applied all the time; students have permanent and online advice, establish study and work teams, consult with external people, access material not included, and develop projects and controlled experiments.

Therefore, it may be that in virtual education there is greater social interaction than in traditional education because teachers develop learning processes through teaching models in which the objective is to get students to achieve learning results. useful for life.

3.1 THE VIRTUAL EDUCATIONAL INSTITUTION

Virtual education is one of the expressions of decisive change that entered the educational system with greater force in this century. In the New Age, educational institutions are an important actor, but with different characteristics and structures from traditional institutions, because they are designed and socialized taking advantage of technological developments, based on discoveries

and revolutionary theories from neurocognition and education. . This process began with the release of data and information for learning from the structured confinements of physical classrooms, breaking down the limitations of time and space, and in this century it has generated a veritable explosion of needs to turn that information into useful and distributed knowledge. in society.

Through flexible and distributed learning processes in virtual institutions, the massive integration of Information Technologies, the expansion, and diversification of types of access, the emergence of learning communities, and the massification of media for ubiquitous learning are experienced. In this context, it is evident that the web and the online environment are used as tools for change in the educational system. In this way, education is innovated to move from the one-to-many model, typical of the traditional institution, predominantly distributive and with almost no interactivity, to a many-to-many model, based on teacher-student-colleagues interaction and characterized by knowledge sharing and collaborative work.

The baseless prejudices of the end of the century, in which the virtual institution was considered low quality, cold and distant, in comparison with the traditional institution, gradually broke down as the learning results could be compared. But the process for virtual institutions to achieve the respect of the community, society and companies has not been easy, in part because the first experiments were structured as a simple matter and only adding computers and the Internet to the traditional model. The experience showed that it was an erroneous approach because it was necessary to innovate everything that means education and for this, it was not enough to acquire technology.

A thorough investigation of all the elements at stake had to be carried out and the pros and cons of each specific strategy were evaluated until an optimal integration was achieved. For example, it was learned that the complexity of the institutional factors involved was an important issue, particularly in those areas that overlap, such as infrastructure and technology, management and administration, communication and improvement, education and training, teachers and students, plans for studies and contents, teaching and didactics model, learning model and learning results, among others, that contribute harmoniously to the efficient and effective functioning of the institution.

The basis of this process is the development of technologies with which increasingly sophisticated tools are built and whose widespread use is imposed, conditional and problematic. On the one hand, the benefits are vast, but, on the other, taking advantage of these tools adequately entails a profound restructuring of the systems and processes in cultural, economic, social, and administrative terms in the institutions. Given that in the New Era education is crucial in social development, the institutions felt impelled to seek alternative solutions to the problems of the educational system in technological developments, to make the training of people and the training of professionals more effective, efficient, accessible, and exploitable.

The inclusion of technologies in educational environments is not a guarantee that this objective will be met, because the options are numerous and the institution must take the necessary time to decide which of them to use. On the other hand, deciding to become a virtual institution entails developing abilities, skills, and capacities in all the staff, an issue that implies transdisciplinary work and a multidimensional vision that, for the moment, cannot be structured in a methodological step by step. So, systems thinking, knowledge management, and strategic planning must be applied to restructure institutional systems and processes.

The virtual institution thus becomes a system in which the academic offer, the administrative and technological structures, and the physical and human resources are articulated and integrated in a flexible, efficient, and personalized way, to respond to the demands, requirements, and expectations of students and society. The virtual institution is not thought of or structured as is commonly done with the traditional institution, where the teaching-learning processes and administrative functions are linear in nature and with time horizons, a model that emerged in the 19th century and has been was perfected in the 20th century in environments of relative predictability in all respects.

The reality is that in the 21st century, this model is no longer functional because the technological revolution has made it obsolete. After all, it drives rapid and constant changes in the demand for and provision of services, such as education. In this sense, it could be said that chaos theory offers a more consistent, albeit less comfortable, the framework for planning a virtual institution since a bi-modal approach is needed to anticipate short, medium, and long-term changes that affect or will affect supply and demand. Therefore, in the chaotic environment of this century, virtual institutions become systems that allow the development of punctuated equilibrium approaches to the revolution of the academic offer, research, services, and relationships.

The advent of this complex environment of communication and information for teaching, learning, and research highlights the need for administrations to develop new skills, abilities, and skills to make effective and efficient use of technological resources for education. Furthermore, the approach to educational planning in this context requires careful and large-scale development of breakthrough skills, because knowledge and expertise have to be combined to offer effective support to students. The success of virtual educational institutions does not depend solely on the proper use of technologies, because the most important thing is the degree to which creativity, inventiveness, initiative, and ingenuity are developed and applied to design and implement the virtual learning environment. teaching-learning.

This natural evolution of institutions towards virtuality also implies a complete harmonization between teaching, research, services, and administration, because the emergence of *separate cultures is not allowed*, as happens in traditional institutions. Generally, in this scenario it is common for academics and researchers to engage in teaching-learning and community service processes, while the administration focuses on designing strategic plans, with objectives other than academic, emphasizing financial and the business model. Although the administration must indeed ensure that sufficient resources are obtained for the functioning of the institution, it cannot be a disjointed objective of the missionary processes, because this will generate tension in internal relations.

The virtual institution represents not only a technological revolution in itself, because it gives people access to education regardless of their location in the world, but also a paradigm shifts in education, because it offers possibilities of education for all. In this model, people have access to educational opportunities beyond their geographic location, and experience the reality of expanded education and ubiquitous learning. In addition, given the explosive growth of information, from which specialized knowledge is extracted, and the demand for the revolution of the educational system in the New Age, teachers need to materialize in that knowledge the classroom discourse and motivate students towards education. permanent.

The objective is not for teachers to reproduce in the virtual institution the work they do in the traditional institution, but rather to take advantage of the media and forms of communication to redesign the work plan, the teaching model, the didactics, and how they verify and validate the

achievement of learning outcomes. Therefore, they require renewed professional development in practically all fields of knowledge, either on their initiative or by creating and stimulating global work networks to learn from each other.

In this same sense of development, traditional institutions have changed much more slowly than the inventive, collaborative, and participatory modes and models of learning that technology offers. In addition, technological development allowed the emergence and consolidation of collaborative, multidimensional, and, transdisciplinary learning spaces that transform the traditional way of providing education. From there derive virtual institutions as spaces for collaborative learning, where the permanent task is to rethink and innovate traditional academic models. In other words, an institution that supports and values the initiatives of teachers to improve the teaching model and didactics, to offer a better education. This is because they understood that change is not an option, but that it is inevitable, whether educational institutions are prepared or not.

This evolution occurs in the context of a wide range of forces that, on the one hand, drive the need for change and, on the other, limit or slow it down, but in general the change is observed from those specific to a region to those that They are widespread worldwide, and their importance is determined by the socio-economic context of each State. Some factors that influence the development of virtual institutions are described below:

- The increasing capacity, flexibility, and suitability of technologies for educational applications, along with the continuing decline in cost.
- The enabling capacity of technology to delegate functions that are traditionally provided by institutions.
- The ease of access to knowledge makes much of what people know obsolete, putting increasing pressure on traditional institutions.
- In this century, people need learning opportunities for life, and they demand an expanded education that allows them flexible access to it.
- Society understands that the quality of the learning experience is enhanced when institutions use technologies to deliver ubiquitous, interactive, and collaborative learning.
- Society's demand to end the isolation and elitism of education, and to offer more equitable access and services.
- The government's perception that this is the way to increase education coverage.
- The business needs employees to keep up to date with everything that has to do with their functions while developing skills, abilities, and capabilities for the challenges generated by the introduction of new technologies in business models.
- Administrators expect that the development of virtual institutions will reduce costs, increase the number of students and allow expansion without noticeable increases in spending.

Of course, these forces are not the only ones, the most appropriate, or the ones that are best directed to the development of virtual institutions, because many are intentional in that it is only intended to copy the face-to-face institution in the virtual one, save costs or increase profits. Likewise, other factors, beliefs, perceptions, and realities hinder the development of a virtual institution:

- In many countries network coverage is limited and in many others the cost of access is high.

- Much of society does not have access to the necessary devices. Even in the so-called developed countries, the disparity in access persists, which widens the gap between those who can opt for virtual education and those who cannot.
- There are rights restrictions on the use of products and materials for education, which restricts exchange and collaboration between institutions.
- The initial cost of implementing a quality virtual teaching-learning environment is an important constraint, which leads institutions to reallocate funds or simply pass these costs on to the student.
- Student care and support practices are not designed to function effectively in a virtual environment.
- The reluctance of most teachers to adopt Information Technology is still very high and is almost always due to factors such as lack of training and concerns about job security and the need to improve communication with students.
- The recognition of learning processes approved in other institutions, traditional or virtual, is a problem for students who want to finish a program in a virtual institution.
- The educational philosophy of the traditional education system in which the center is the teacher, and where learning is structured and directed by him.
- Public policies related to education still do not adequately adjust to the recognition and acceptance of virtual institutions, and most are simple copies of experience in processes with traditional insights. This makes many countries decide that virtual education is only for adults.

While these forces and factors are not an exhaustive list, they are enough to make one realize that it is not the technologies that should be questioned, but the purpose and use to which they are put in institutions, which is likely to influence the biased opinion of many people about virtual education. For this reason, in the administration of a virtual institution, it must be ensured that the planning and use of technology are linked to educational planning, with the objective that the integration is adequate and sustainable in terms of access. In other words, the selected technology must be the most appropriate for the characteristics of the students, the nature of the study plan, the skills and abilities of the professors, and the budget available in the institution.

To achieve this objective, the institution must demonstrate that the application of technology in education improves teaching practice because if teachers are aware of this, they are more likely to change their behavior and feel motivated to develop the necessary skills and knowledge. The institution must offer them the means and facilities to achieve this while establishing them as an essential part of the change strategy. Therefore, in a changing world and a changing society, the environment of education has to change, because so do the factors that affect its contexts, such as globalization, society, technology, demographics, and the importance of learning. permanent and for life.

In any case, and if the objective of teacher development in the virtual institution is to change, it must also change and abandon the existing technical and administrative infrastructure for traditional education. The reason is that, sooner rather than later, this infrastructure is going to become a barrier to change, because the dynamism of operation must be adjusted to the developments that support it and to the demands and needs of students and teachers.

In this order of ideas, institutions are forced to modify static bureaucratic administrations, lacking dynamic flexibility, because the New World Order shows them that emphasizing changing students, staff and teachers is not the way, but the first thing to change. It must be the institution.

3.2 THE VIRTUAL CLASSROOM

When the term *virtual* is used in an educational context, it is common for opposing positions to arise, for example, those who affirm that it strengthens the real and that it is an invaluable opportunity to solve the problems of the education system, because it allows building an improved model of the reality and broadens the horizon of creativity and knowledge. On the other hand, some insist on referencing the distance that separates the real from the virtual and that is a risk for society because it generates a progressive loss of contact with the real world. Given these appreciations, it is difficult to consider one of them over the other, because undoubtedly both may be right, and it is still early to assess whether virtual institutions and virtual education achieve better learning results or, on the contrary, generate insoluble questions.

The 20th century taught us that it was correct to aim for the traditional resolution of problems, but that we should be predisposed to experimentation and exploration of new scenarios. In the 21st century, society is experiencing a dramatic fracture, difficult to think about or imagine through words, which in this book is called the New World Order. In this reality, and as much as people want to face the New Age, they are still sensitive to the flame of the past. Therefore, in this new scenario, we must try to resolve the controversies about the virtual and think about how we can take advantage of the potential of technology in the educational context, although complicated characteristics are glimpsed, we have to be positive that they can be resolved.

These controversies should serve to unify aspects such as the virtual institution and the virtual classroom as learning spaces in which education is provided. But the virtual classroom cannot be defined simply as a space in which the traditional environment is simulated, because the learning processes are developed through online interaction, which traces its specificity. It is rather a territory of mediation in which relationships between students-teacher, student-colleagues, student-materials, and student-teacher-globality develop or intersect.

The definition of a virtual classroom needs further analysis, although while progress has been made towards relatively unified concepts, views and opinions on the subject persist. In particular, when analyzing the tendencies aimed at finding a joint definition, it is observed that sometimes they advance in harmony, although they start from different assumptions:

1. On the one hand, some link the virtual classroom with the development of a real technological system, organization, or infrastructure, because its architecture metaphorically reminds them of the idea of a space in which teaching-learning processes take place. For this reason, they pay special attention to the components and the elements and phases of the process, as well as to the supply of educational materials and resources. They focus above all on the structure of the learning process and the complexity of the environment, emphasizing aspects such as planning and organization.

2. On the other hand, some tend to define the virtual classroom through the identification of the roles of the actors involved and the analysis of their modes of interaction, identify it in a broad sense and perceive it as a territory of mediation and, therefore, as a social space. The center of this definition is the interaction and the communicative and collaborative dynamics that occur in the virtual classroom.

In the first trend, there is an inclination towards the theories and metaphors around virtual education, while the second has an obvious connection with communication studies and with the philosophies of open and distributed education theories. Different philosophies influence the

representation of the virtual classroom and, therefore, its definition and the classification of interaction models, because it seems to be transversal to the point of view from which it is observed, leading to a distinction between asynchronous virtual classrooms and synchronous virtual classrooms.

The virtual classroom is a space in which the interaction between teacher-students-context is permanent, and dialogue, analysis, and knowledge construction are carried out through the mediation of technology. Therefore, the virtual classroom is a social space where the actors interact continuously and where these relationship dynamics can: 1) favor the active participation of the student when interacting with the resources and materials, but with the presence of an advisor; and 2) emphasize collaborative work among peers. The combination of these moments defines the virtual learning space, however, the virtual classroom must be flexible, because there are interactions that require both moments, that is, a kind of mixed interaction characterized by the coexistence of one-to-many relationships, one-to-one and many-to-many.

In the same way, and although it seems that in the virtual classroom, the structured material is for individual use, the reality is that it is an integral part of the learning process and constitutes a part of the body of knowledge addressed by the collaborative learning experience. We must also accept that the virtual classroom is a knowledge network where the collaborative dimension, reciprocal tutoring strategies, and the diversification of active roles are amplified.

This marks a substantial difference from the traditional classroom, where the relationship scheme tends to place the figure of the teacher at the center of the stage, and access to resources is predominantly individual. In the virtual classroom, by contrast, center stage is taken by students and the dynamic interactions they engage in, which together create an open and flexible space for learning.

Hence, the virtual classroom is considered a social learning space, where the focus is community spirit, which is structured with well-defined areas to promote interactions, whether it is for participants to introduce themselves, ask questions, hold discussions or share knowledge. The idea is to make it compact because otherwise, it would be more like a traditional classroom where the teacher gives the lecture in a room, then the students work in groups, consult in a library and try to find knowledge in the results, almost always without the necessary advice and outside the classroom.

On the contrary, the virtual classroom is a space in which students, when communication is synchronous, have permanent advice, consult the material, access complementary material, analyze the results, and find knowledge collaboratively, without having to leave the classroom. classroom. When communication is asynchronous, the classroom is open for students to review concepts or reinforce specific topics, and also to carry out experiments, in an independent work process that allows them to achieve the expected learning results.

To better understand the structure of the virtual classroom and what happens inside, we can start with a formal representation that highlights the ways and the times with which students achieve these results (we refer to students who enter virtual education for the first time). In the process, the phases related to the development of the skills that students need to progress to achieve the learning outcomes are identified:

1. *Computer skills*. They are developed faster and easier because students do not require particular efforts to familiarize themselves with the platform of the virtual teaching-learning

environment unless it is particularly complex. In any case, the development of computational abilities, skills, and capacities is preliminary to any experience in virtual education and has to be resolved quickly.

2. *Abilities for accessing and understanding the content*. The main difficulty that students encounter when they enter the virtual classroom for the first time is not related to understanding the content, but to how it is presented. In general terms, students are used to using textual content, so they may feel uncomfortable when consulting it in hypertext and multimedia formats. Here they need the accompaniment of the teacher and collaborative work with classmates because the idea is that the group advances harmoniously in the learning process.

3. *Time management skills*. To maintain a constant and harmonious relationship with the virtual classroom space, students learn to manage the time they dedicate to their studies, that is, they learn to self-control each moment in the virtual classroom and to respect the rules of access, behavior, and achievement of results. Every work session in the classroom has a clear objective, because, as a component of the web, the virtual teaching-learning environment offers many alternatives to work, so the student can end up *shipwrecking* and not reach the objective set. Again, the teacher's advice and work with peers are essential to developing this skill.

4. *Interaction skills*. After developing the previous skills, the student learns to interact with peers in the virtual classroom, a difficult skill to develop and which is a determining factor in successfully achieving learning results. This is achieved with perseverance, respecting communication protocols, learning to listen, and making valuable contributions. In this way, the student integrates into the group and the classmates recognize their value as active members.

A key issue to developing a rewarding experience in a learning process in the virtual classroom is to learn to control the time factor and develop abilities to solve the difficulties of interaction. This varies from person to person, because each structures their learning style and because students are more or less familiar with the technology. The development of these skills also depends on how the learning process is planned, and how and when teachers and peers can identify, respond to and help the struggling student.

Difficulties generated by prejudices can arise in the virtual classroom, for example, to participate in virtual education you have to be a specialist in the use of technology, in virtual classroom affectivity is less, and it is difficult to find the time to do the activities or that the interaction is cold and impersonal. In essence, these are the same problem areas found in any traditional classroom.

This question is solved with logic and a well-structured virtual teaching-learning environment, offering an introductory learning process in which the student becomes familiar with the virtual classroom, with the teachers, and with the classmates, using Artificial Intelligence to monitor the synchronous and asynchronous work of the students, and not waiting until the student manifests the difficulty, but identifying it in time to solve it together. Those difficulties can be:

1. *Lack of computer experience or familiarity with devices*. This aspect is important because if the group does not have the same level of confidence and skill in handling the tools, a climate is generated that does not benefit learning. Teachers must be attentive and intervene to help students because many times they disguise the difficulty with excuses about technical problems. These difficulties are the ones that are most easily and quickly resolved, for example:

- Develop a technological platform that responds to the needs of the learning process, is technically reliable, easy to use, and fast and efficient. Of course, this does not solve all the related difficulties, but it can facilitate the solution to many of them.
- Previously recognize the level of knowledge of students with technologies in general and, in particular, with those that structure the virtual teaching-learning environment.
- Establish an agile and efficient support service that students can use to resolve their difficulties.
- Ensure that all students have acquired the necessary skills before starting a learning process. This is achieved with a well-structured induction.
- Motivate peer tutoring, because students often feel calmer exposing the difficulty to a partner, which encourages those with more knowledge to help the most insecure.

It must be added that the difficulties of the students about the access and comprehension of the contents are also magnified, because: 1) they find it difficult or impossible to access solutions from the teacher, and 2) they have the feeling that the resources online are passive. So, the teaching model must ensure that this does not occur in the virtual classroom.

2. *A poorly designed teaching and didactics model*. The teacher is obliged to sufficiently clarify the activities of the learning process and the strategies to be followed; to keep the *enthusiasm* of the students active; to identify if students follow your suggestions, to what extent and at what pace; to produce, re-elaborate or relocate materials and resources that serve students, respecting their learning style; and to design didactics that motivate the student to participate and create knowledge.

   The professor takes into account that many of his students come from traditional education, where they are accustomed to direct communication and the characteristic question-answer dynamics, so they generally tend to think that the traditional classroom is more productive and effective than the virtual one, and that the contents that it offers are more difficult to manage and assimilate. These difficulties are addressed by seeking, above all, to highlight the advantages of the virtual classroom in terms of knowledge management and distribution: 1) remind students that the material and documentation are available at all times for them to review and answer questions; 2) offer spaces for discussion and analysis in which the teacher and the students share, or between the students, or between all of them and a guest specialist; and 3) stimulate the spirit of shared knowledge and facilitate peer tutoring as a strategy to address difficulties.

3. *Quality and amount of time spent*. It is common for students to express difficulties in dedicating enough time to virtual learning processes because they have to combine their activities, for example, work or family, with those they do in the virtual classroom. To help students overcome these difficulties, the curriculum is structured with short educational experiences and with compact and modular learning processes, in such a way that they do not conflict with other activities.

   One solution consists in designing sustainable learning processes, which are developed in the virtual classroom through collaborative activities, and establishing precise deadlines to comply with them; verifying that students respect the delivery or completion date; defining precise rules about the importance of respecting the times; and guarantee constant visibility of the process, in such a way that students have the sensation of being accompanied and are motivated to stick to the schedules.

4. *Communication overload*. In the virtual classroom, situations are generated in which the number of messages grows disproportionately, to the point that it becomes intolerable for everyone. The causes that can, directly or indirectly, lead to these situations are:

   - *Re or self-knowledge*. This is because students feel the need to get to know their peers more widely, so they use the communication tools of the learning process to introduce themselves or to be noticed.
   - *Disturbing agents*. Because people try to learn how to use the tools in the middle of an analysis or discussion or get carried away with enthusiasm, which generates cross-messaging and interruptions that annoy others.
   - *Overuse of tools*. Although in a virtual environment, students and teachers have a wide range of tools for communication, the tendency is to use mostly the simplest or those with which they are most familiar.

   These causes are not due to a poor design of the virtual environment, since knowing each other and communicating is understandable between humans, as is the desire to be noticed or use the simplest. But they must be solved, either by defining roles and rights that everyone knows and respects, or by designing a communication etiquette in the virtual classroom that tells all participants the rules for sending and receiving messages.

Both the teacher and the students must understand the socio-technical practices that are developed in the virtual classroom, that is, it is an environment where they have the feeling of being part of the same learning process, regardless of where they are physically, in the one that develops a sense of joint belonging that is governed by certain norms and rules, both of behavior and interaction.

Another issue that differentiates the virtual classroom is the change in the role of the teacher because it goes from being the source of information and knowledge to execute the role of a facilitator-advisor who encourages collaborative work. In this way, the virtual classroom becomes a space where students take control of their learning process and carry it out at their own pace and at the times they define it. The teacher is in charge of encouraging them to be autonomous, resourceful, and independent, and focuses their attention on the learning process and on the achievement of the learning results: what they learn, how they learn, the conditions under which they learn if they are creating and applying knowledge, and how they learn for life.

Likewise, in the virtual classroom, the meaning and function of the contents change because they are no longer in the *shadows* to become a vehicle for students to develop abilities and skills. In this way, learning is achieved through a meta-cognitive process in which students become aware of their strengths and weaknesses, and how to use them to improve in areas with difficulties, therefore, they learn to learn. In the virtual classroom, students are trained to use the means at their disposal and create a kind *of learning contract* in which they set goals for themselves, *hire* the teacher to accompany them in each learning process, and advise them in the achievement of learning outcomes.

This is not an easy task to achieve and requires the application of collaborative practices and other forms of instruction, such as challenge-based learning, project-based learning, active learning, and cooperative learning. The point is that many students, especially adults, are not necessarily prepared for virtual education, so they must be taught to learn, that is, taught to become better learners, to investigate and build knowledge, and to be self-directed. The result is that students can continue to learn for life and do so more effectively than in the classroom.

Once students understand their learning capabilities, any learning process in the virtual classroom helps to modify their vision about the abilities, skills, and abilities they must develop. In the same way, learning in this way reinforces their beliefs and behaviors for permanent and sustained learning. But it is not a simple process that can happen overnight, because many students resist and continue to think that they entered virtual education *to be taught by the teacher*. Therefore, implementing a student-centered education requires patience and attention to changes in the roles and functions of the actors involved.

These roles and functions begin with the acceptance of social presence and its importance in the development of learning processes in the classroom, where all those involved must make sense of who they are as real people. But in the virtual classroom, other forms of presence also come together, such as cognitive and teaching, as necessary elements for the development of processes that overlap to create a learning experience. Cognitive presence is an element associated with success in education because it is the extent to which the participants in the virtual classroom are capable of constructing meaning through sustained communication and collaborative work.

The teaching presence is generally the role and function of the teacher, although it is a role that is shared among the participants since the working relationship in the classroom is many-to-many. Although the teacher performs more specific functions, such as the design of the teaching model and didactics; the selection, organization, and design of the contents; the application of the model to verify and validate learning and, most importantly, to facilitate learning processes.

As a functional activity in the virtual classroom, facilitating learning processes may or may not have the expected success about learning, therefore, to determine its effectiveness, it is necessary to make the right decisions regarding: 1) modes of communication, 2) didactics, and 3) the architecture of the learning process. About first, the virtual classroom is the ideal scenario to combine modes of communication, such as text, audio, and images, with the advantage that interaction, dynamism, and multimedia can be added to them. On the other hand, the text, the audio, and the images are used individually or in combination to design the didactics, which are the psychologically active ingredients of the virtual classroom. Then, the didactics are conceived as the basic support of the learning processes, and to achieve this there is a wide range of options, such as definitions, descriptions, examples, demonstrations, and experimentation, all framed in the practice of feedback.

Likewise, the architecture of the learning process is an important component for the achievement of learning outcomes in the virtual classroom and varies according to the number and type of interactions available to students, the grade and the source of guidance offered, and the organization of content and didactics. Four architectures for learning processes are proposed in the literature:

1. *Receptive:* It is a learning process that mainly delivers content, such as a conference or the presentation of a documentary. Instruction provides information that students *soak up like sponges*; some incorporate text, audio, and visual elements, as well as a variety of didactics, but since it is static, it includes little or no opportunity for students to interact.

2. *Directives*. They are characterized by offering brief learning processes that provide a small amount of information, accompanied by examples and practices with corrective feedback. Generally, they are a kind of checklist that describes the steps to complete a procedure, followed by a practical exercise that involves comments to point out errors or confirm successes.

3. *Guided Discovery*. It is an architecture that requires students to be involved in the learning process to achieve the stated results. Unlike directive architectures, which are instructive, the learning achieved here is more inductive, because the basis of this architecture is the premise that learning occurs just at all times, whether it is solving a problem, executing a project, or being discussed among colleagues. That is why the most used didactics in this architecture are learning based on challenges and projects, and learning based on scenarios.

4. *Exploratory*. A variety of didactics and content are incorporated into exploratory learning processes, and students are encouraged to access and use them based on their needs and expectations. In these environments, the control of learning is exercised by the students and they are free to select what content to access; In addition, they are in charge of promoting the environment and, therefore, defining the pace and study times, adjusting them to their learning model.

The exploratory architecture is the most appropriate to develop learning processes in the virtual classroom, but to be successful in achieving learning outcomes and keep students motivated, the teacher must:

1. Plan and prepare in advance the main elements of the learning process, such as the teaching model, the didactics, the interaction, and the communication model.

2. Use learning processes with asynchronous events, which impose less cognitive load by allowing students to review and reflect at their own pace, such as labs, project development, and real-life practice.

3. Stay focused on student work and ensure examples, demonstrations, and practical exercises are placed in realistic contexts; You can also plan an application project that requires students to apply the skills developed in the learning process.

4. Design interactive learning processes, since relevant interactions help students not to be scattered or distracted by other activities. In addition, students' responses to interactions help compensate for the lack of body language in face-to-face processes and are essential for acquiring new knowledge and developing new skills.

5. Involve the social presence in all the activities of the learning process, since, when it is structured correctly, the commitment of each student to the others results in greater learning than individual work. This is directly related to the interactivity of the processes, which increases the possibilities for everyone to interact while increasing their knowledge. It is also advisable to involve students in review activities and open opinions on the work and presentations of their peers, which turns the virtual classroom into an active space for social presence.

6. Take advantage of the natural deployment of the virtual classroom, that is, the screens, to use appropriate visual elements in the entire learning process to transmit content. This feature of the virtual classroom, added to that of interactivity, gives students the feeling of inclusion and keeps them interested in the learning process.

7. Manage the cognitive load in the virtual classroom, because when it is high students get discouraged and it forces them, in many circumstances, to drop out. To achieve this, it is necessary to use relatively short, interactive work sessions with striking visual elements; use

real examples to illustrate each topic, and ensure that students have access to help before, during, and after each session.

A virtual classroom whose architecture takes these insights into account supports active learning because it provides an environment with tools, materials, content, and learning opportunities for contextual discussion, which motivates students to participate in processes and activities. learning activities, and not just reading static content.

An environment of this type is dynamic, contextual, and interactive and, although no general way of implementing a virtual classroom of this type has been identified so far, its design, architecture, and implementation depend not only on the teacher and his experience but also on the participation of professionals in neurocognition, education, and visual design. For this, the acceleration of technological developments will always be one step ahead of the design and use of virtual classrooms, so innovative features may appear that can be used to keep virtual classrooms up to date to a certain degree.

3.3 THE VIRTUAL STUDENT

The purpose of any learning process is to get students to learn and, to achieve this effectively, the institution must first understand and understand the characteristics of students and their specific needs, and then design learning processes to satisfy them [2]. In a well-structured educational system, the design of learning processes is so flexible that it adapts to each student as they progress through a program; however, the current educational system does not come close to this reality because it is still based on theoretical and obsolete pedagogical promulgated in the 19th century [55].

In virtual education, it is possible to design how to identify, recognize and individualize students, because technology offers the necessary tools to do so (see *Chapter VII. Intelligent Education)*. For example, in the registration process and during induction, questionnaires are structured and an Artificial Intelligence tool is used to determine, among others, the following characteristics:

- Age
- Cultural and linguistic background (cultural stratum)
- Previous educational experience
- Disabilities or challenges that the virtual teaching-learning environment should address
- Technological and computer skills
- Written and verbal communication skills
- Level of adaptation to an interactive learning model and shared work
- Adaptation to change

This information, and the rest that is considered necessary, must be sufficient to design and structure teaching models, didactics, and processes of verification and validation of learning that allow the teacher to approach the desired personalized education. Of course, with a well-designed virtual teaching-learning environment and with the permanent support of the available technology. The technology that supports the learning environment, as well as the appearance that the student sees (interface), can make a significant difference in motivation and the level of achievement of learning outcomes.

The student is an important subject in the context of virtual education, because, on the one hand, he is the specific subject, recipient, and exploiter of the services offered by the virtual teaching-

learning environment, and, on the other hand, he is the individual who. The system must help to train as a person and as a professional so that they can perform in a mature, conscious, active, and qualified manner within society.

The point is that in the New Age people with a high cultural level are required, who develop in the process of formation and training, which enables them to actively integrate into the Consumption Society, where they will contribute their potential to help the development and survival of humanity. Virtual education is a space designed for students to achieve these goals, in addition, it is a context that is supported by technology and that allows teachers to use the most appropriate revolutionary educational theories.

The changes that are taking place worldwide in education and training, and in general in all areas of human development related to empowering people's capacities, abilities, and skills, have implications that virtual education takes advantage of to ensure that student learning aligns with these trends. Virtual interactive participation is an obvious means to promote deep and constructive learning and to develop life skills. But the education system still adheres, for no apparent reason, to the principle that students should be classified into *generations*, and from there it structures models and promulgates regulations to offer them general education, ignoring their particular needs.

Although there is a large volume of literature presenting classifications and names for human generations, especially those whose members were born after World War II, it is not possible to state with certainty that they are widely and scientifically accepted [56, 57]. Part of this argument is based precisely on the high number of denominations: *Y, Z, Net, APP, Digital, Millennials, Baby Boomers, Alpha, Silents, Boomlets, Ni Ni, and I*, ... which often refer to the same group of individuals.

It seems that there is a marked interest in proposing names at random based on arguments that generally respond more to corporate needs to find new markets and buyers. In this sense, what is worrying is that the education system plays into this habit of *generalizing* and that it uses it as an argument to hide its inability to update itself, innovate and adapt to the contexts and learning needs of the New It was, while he blames the failure of his models and policies on the fact that the students belong to one or the other of such generations and that, therefore, not much is expected of them.

That is why the fashion in the educational context is to name those born in the New Age as the *digital generation*, only because they began their existence in a world dominated by this type of technology. But that also does not have a solid and sustained foundation, not only because digital technology has been around for a long time, but also because it is not possible to generalize certain characteristics to these students. For example, it is risky to affirm that in any country this *generation* has the same level of access to technological developments or that they use them in the same way and with the same familiarity, because the purchasing power and cultural stratum of their families are different, the interest or acceptance for technology is not the same, the economic stratum cannot be compared, and their heredity and genetic memory is not an equalizing factor.

Currently, it is possible to speak of the emergence of a *new category of students*, made up of individuals born at the end of the first decade of the century. According to different authors [58-61], these students present characteristics that substantially differentiate them from those born

at any other time in human history. Partly because they were born and developed in a highly changing and constantly revolutionizing environment, where countless technological advances are disseminated daily and new media and forms of communication are created, and where they potentially have unlimited access to information and content everywhere. the world. In addition, they generated a high capacity for adaptation to the challenges and demands that this environment poses, which is why different research areas affirm that they are *multifunctional*.

have developed increasingly diversified and extended attention, which has led many to conclude, also hastily, that they suffer from *attention deficit* [62, 63]. The reality is that the fact that these students consider that maintaining attention in a single direction or a specific subject is a monotonous and boring activity because their world is dynamic, multidimensional, challenging, and demanding, something that in virtual education it is well understood.

Their attention levels vary depending on the motivation, emotion, and enjoyment they obtain, and the time of day in which they are presented, characteristics that are taken into account in the design of virtual teaching-learning environments. According to Serna and Serna [2], the new category of students reflects the characteristics shown in Table 1.

Table 1. Characteristics of the new student category

Characteristic	Description
Attracted	They learn about the world by paying more attention to things that surprise and challenge them
Dedicated	When they start a task they don't want to stop until they finish it
Determined	They make decisions with little basic information
Empathic	They feel part of the triumphs and defeats of others
Challenged	What most attracts his attention is the challenge of completing an activity
Concentrates	Focus on finding solutions to challenges and problems
Attentive	They pay indefinite attention to activities that engage and challenge them.
Selective	They select the activities and do not like to be imposed
Teamwork	They form work teams with affinity to execute the selected activities
Multifunctional	They carry out several activities at the same time, even if they are not related
Use of technologies	The basic tool to carry out their activities is technology
Multidimensional	They discover the information they need from multiple dimensions
Adapted	They easily adapt to any context or situation
Hyperlinked	They develop large-scale links through technology
Multicultural	Appreciate cultural diversity and learn from each other
Incentivized	They prefer activities in which they receive incentives
Controllers	They seek to have control over the development of their activities
Inclusive	They have no problem including others in their activities
Risky	They take risks without fear of failure
Immediate	They opt for activities in which they obtain immediate results or in a short time
Competitive	Without entering into conflicts, they are highly competitive with themselves and with others
Insurance	They reflect high levels of security when making a decision
Sociable	They like to share with others, both personally and virtually
Optimistic	They are not discouraged by failure, because they always think they will have another chance
Realistic	They know the world from real reality and easily disconnect from virtual reality
Ambitious	They always want more, both in challenges and incentives
Confident	Demonstrate confidence when sharing with others
Independent	They do not like to be manipulated and reject impositions
Globalized	They easily establish global relationships to find solutions to challenges
Open	They are willing to listen and do not accept arguments that they cannot verify and validate

These results identify that they have a marked inclination towards challenges, receiving rewards, and interacting with others, which It must serve so that virtual education integrates activities such as conquering goals and achieving achievements into the curriculum; and so that teachers, applying didactics that allow them to immerse themselves in realistic and challenging environments, design a teaching model with which students achieve effective learning.

These same researchers also found a series of activities that attract the attention of this category of students, and to which they spend most of their time [2]. Table 2 presents the results, organized in descending order by the time invested in each activity.

Table 2. Activities in which the new category of students spends more time

Exercise	Features that grab your attention
Video game	Challenging, dynamic, realistic, practical, flexible, rewards, repetition, definition, aids, concrete, inclusive, motivating, cooperative, tiered, fun, relevant, intriguing
Internet	Share, read, consult, ask, know, movement, images, short texts, captivating
Decipher challenges	Short, real, to the point, catchy, doable, comparable, informational, rewarding, fun, intriguing
Solve puzzles	Understandable, entertaining, fun, doable, rewards, challenging, comparable
TV	Funny, non-repetitive, movement, little dialogue, body language, hidden text (dare), suspenseful, intriguing
Social sharing	Enjoyable, using technology, other countries, with peers, shared interests, and other cultures
Discuss	Familiar, pleasant setting, friendliness, rewards, current issues, resolving concerns, being heard, prominence
Read	Short, images, attractive, colors, letter size, up-to-date, challenges, fun, rewards, meaningful
Crafts	Challenges, fun, movement, color, rewards, small, interaction, with technology, updated
Outdoor game	Fun, with pets, challenging, short, appropriate space, not repetitive, not tiring, prominence
To draw	With technology, colors, movement, short, updated

These activities are carried out with a kind of *mental checklist* in which they must necessarily find answers to: *what, why, for what, where, how, with what, with whom,* and *what would happen if,* because in this way and in the information they collect, they find meaning in doing them, that is, they feel challenged and motivated. In addition, for them, there should not be an activity called *learning*, because they consider that with this checklist they get answers to their questions at all times and places (*ubiquitous learning*). That is why *learning* does not appear on the list in Table 2, and it is not because they do not dedicate time to it, but because they have developed a different learning style than what is traditionally believed that all students have because they learn in everything. what they do (*project and challenge-based learning*).

That is why the educational system must realize that each student has a unique and unlimited potential to learn, which challenges teachers to embark on a quest to identify and discover it, and to develop a teaching model that harnesses this potential for the benefit of the student. learning. Taking advantage of the contributions of theories such as active-collaborative learning, in virtual education students are guided to maximize their potential. In virtual teaching-learning environments, it is clear that the most important question asked in their design is not what a learning process should contain, but rather how to design a teaching model that promotes deep and holistic learning.

At the same time, the study plan must take into account that students are very flexible in their learning style, and integrate content that gives them opportunities to build meaning in an educational environment. To achieve this, and knowing the characteristics of the students, virtual education promotes productive learning, in which students explore, discover and experiment. This means that they have to face the challenge of working beyond their comfort zones and carrying out activities that, necessarily, do not coincide with their preferences, because the knowledge that learning truly generates is transdisciplinary.

By designing learning processes from this perspective, in virtual education, the student develops all the latent capacity to learn and solve problems integrally. In addition, for students to achieve learning outcomes, the curriculum integrates concepts such as: 1) *learning style*, conceived as a person's preferred way of processing information and solving problems within a given context; 2) *flexibility* of learning style, thought of as the ability to adapt that style to the demands of a learning

process; and 3) *active learning*, a continuous process of construction of meaning derived from the educational experience, which is continuously monitored and modified.

Theories that allow a better understanding of the new category of students, who seek to improve the way they achieve learning outcomes, are also taken into account. Among these theories are: 1) *multiple intelligences*, with which teachers are urged to innovate their teaching model, the didactics they use, and how they verify and validate learning results; 2) *collaborative action learning*, which offers a range of knowledge about how the student adapts to the context of teamwork; 3) *whole brain learning*, in which learning is seen as a life skill, which is practiced through collaboration and teamwork.

For them to be successful in virtual education, other considerations are taken into account in the classification that the students of this century are:

- Open-minded about sharing knowledge, work, and experience as part of the learning process.
- Able to communicate through writing.
- Self-motivated and self-disciplined.
- Willing to talk in any situation.
- Able and willing to dedicate the necessary time to each learning process.
- Capable of developing learning processes based on challenges and projects.
- Aware that critical thinking and decision-making are part of the learning process.
- Able to adapt, understand and use technological developments.
- Sincere and aware that first, the brain connects, and then the mouth opens.
- Sensitive to quality learning that arises at all times and places.

This makes them successful in a virtual teaching-learning environment because they are *noisy*, active, and creative students in each learning process. In addition, they hope that the educational experience will keep them motivated to participate, analyze, discuss, work in a team, and experience knowledge. The reason is that most of them have been in contact with technology and the world since childhood, and have fun with peers from all over the world, from different cultures and with diverse knowledge. Hence, upon entering the educational system, they expect learning processes to develop through active forms, which enable them to seek knowledge, as well as entertainment.

Then arises one of the challenges that the education system must solve, because, while students live online, use all kinds of technologies and participate in social networks, adults, including teachers, are just arriving in the world of technology, and most barely know how to send and receive emails and messages, resulting in a kind of *generational technology gap*. The students of this century rarely read a physical book or go to the library, because they prefer technological means to carry out their readings and consultations. Whereas, although the use of the Internet has increased among adults, they often have to seek additional training that allows them to change their thinking and practice to successfully use these tools for academic purposes. Consequently, virtual education becomes a solution to this challenge, because it forces teachers to become familiar with technology and explore revolutionary theories and means to structure a teaching model according to the demands and needs of the new category of students.

An important issue that differentiates students in this century from those of other eras is that they continually need to experiment, explore, manipulate, and test ideas in real, interactive settings to actively create knowledge and meaning. That is why collaborative, shared, and teamwork are important in virtual education because they are powerful forces in any learning process, where

students interact with knowledge, with the learning environment, and with their peers. By providing them with learning environments that encourage the creation of personal meaning, the social construction of knowledge and meaning, and the emergence of learning, the virtual teaching-learning environment is a powerful tool to reduce this generational technological gap.

In this learning environment, the student, in addition to being an active actor and committed to the generation of knowledge, assumes part of the educational function by collaboratively sharing what they learn with their peers. That is why in virtual education, learning processes allow and facilitate the exchange of roles between students and teachers because everyone has something to teach and something to learn. In this process, each one assumes their role with dedication and responsibility, which turns the virtual classroom into an interactive space where students feel motivated to fulfill their commitments.

This implies that the student is responsible for using the guidance they receive from the teacher in a meaningful and responsible way. That is, students are responsible for actively seeking solutions to problems and diligently developing each project, in addition to adding something else to the fulfillment of what was planned, such as achieving unestablished learning results. For that, they see problems from various perspectives, including those of colleagues, friends, or families.

This is a way to make them question the assumptions that arise in collaborative work, as well as their assumptions and ideas, remain interested in generating the knowledge required in each learning process, build new forms of knowledge, and give another meaning to learning simple fact of learning. In addition to developing research and critical thinking skills, they learn to critically evaluate their learning style and subject area content. But it is not about students undertaking this process alone, because the success of virtual education is the capacity of the environment and the willingness of teachers to design and facilitate collaborative learning processes. In a virtual environment, students work together in the development of projects and generate the ability to understand and critically evaluate the material, tools, and information. Also, because they are motivated to search other sources for what they require for this purpose, they learn to share the resources they discover.

In this sense, the virtual classroom is structured to offer students the possibility of working and learning collaboratively. This could not be achieved without the accompaniment of the teacher, who guides and encourages them to develop skills to dialogue and share in a group the knowledge they require to achieve the learning results. A learning process structured in this way helps them to develop critical thinking, to investigate, and to identify the information for the development of each project. One idea for this collaborative work to expand is for professors from different areas, or institutions, to agree so that students share their experiences.

Despite everything and as happens in traditional education, in virtual education some students fail, generally because they lack some of the necessary skills to be a virtual student, but in most cases, it is due to how the institution and the teachers impart the learning processes. Although there are students who learn better when they receive feedback from the teacher face to face, have classmates next to them, or study in a defined place or a library, this is more characteristic of adult students, who have gone through some learning process in education. traditional and shaped their brain to study that way, or those who do not have access to technology, because this discourages them from entering virtual education.

Another thing happens with the majority of young students, who enter the system with greater skills to use technology, are accustomed to conversing with peers around the world, and prefer to

study at their own pace and time. Also, because most of their activities are done online, their brains have been shaped by visual, fast-moving, hypertext and gaming environments. Therefore, it is rational to think that they will enjoy an education in those same terms, that challenge them and motivates them to look beyond what they experience in a virtual environment.

3.4 THE VIRTUAL TEACHER

Long before the appearance of the printed book, instruction was an oral tradition based on oratory, where the *wise* went up on a stage to teach. When the time of generalized education arrived, the role of these wise men began to be shared with the *experts* who wrote books. But the language in which they were written was not available to everyone, so the *teachers appeared* as interpreters between the expert and the people who wanted to learn. Over time, the *business* of teachers was consolidated around the design of classes to meet specific learning objectives, and that has been one of the supports of the education system as the only way to support learning.

But in the 21st century and thanks to the constant development of technology and scientific discoveries related to cognition, the need to revolutionize the educational system arises, because, with the appearance of virtual education, it is increasingly accepted that most of the learning takes place outside the classroom, which has led to the need to re-evaluate the role of the teacher.

The development of new capacities, abilities, and skills in teachers is essential for the success of virtual education. Before an institution thinks about designing, creating, and implementing a virtual teaching-learning environment, it is necessary that it first have the right teaching staff for it to be successful. The virtual teacher must accept that his role changes in these environments, because he will no longer be the center of learning and will become a facilitator, mentor or advisor, that is, he will be more like a director who makes sure that all the actors play their role. and that the learning process runs smoothly from start to finish, adding your experience only when you notice that they need your help.

This change begins when the teacher accepts that technology is responsible for disseminating information and, based on mastery of the subject and their skills, is dedicated to leading students to discover knowledge to facilitate the achievement of learning outcomes. Furthermore, the emphasis of your work shifts from just presenting information to a group to helping each student identify its relevance, and discover knowledge in it. This emphasis on individual orientation through learning based on challenges and projects requires that the teacher be a specialist in the area, with professional experience, and with an inner inclination to work collaboratively so that the students advance in the learning processes.

This is often not as easy as it seems, because getting older teachers to accept and internalize this paradigm shift in teaching, and to get them involved and motivated toward the change, can be an arduous process. Unwittingly, these professors have entered a global information environment where they are constantly struggling to adapt to change, and where many are barely staying afloat. This forced uprooting from tradition, where they carried out their work almost automatically, has generated a struggle for them to remain current, to understand and comprehend the changing profiles of students, and to constantly innovate their teaching model and didactics. Furthermore, they are harassed daily with texts, videos, and re-training processes offered everywhere to help them overcome these difficulties, most without a proper cognitive dimension.

The development of re-training plans for teachers should be assumed by educational institutions that decide to implement virtual teaching-learning environments, and although designing a

teacher development plan of this type is a challenge, its objective is to help teachers to synthesize the new knowledge and to adapt the technology, the teaching model and the didactics to the needs of the learning process. And it should be for all teachers, because, contrary to what is thought, recent graduates of education faculties have not developed the necessary skills either. Partly because these faculties are still governed by outdated theories and many consider that teaching in virtual education is the same as doing it in traditional education. To verify this, it is enough to find out how many of these faculties offer professional training programs for teachers for virtual education.

The reality is that the classroom context in traditional education is very different from that of the virtual classroom because here the teacher loses control of everything that happens inside. For example, many teachers argue that it makes it impossible for them to observe the visual signals that students display, and that allows them to have control over the group, so they resist, sometimes fearfully, the transition to virtual classrooms.

The premise for these teachers is that they need to learn to detect the visual and discrete signals that students emit, because in this way they can subtly analyze, consciously and unconsciously, the state of mind of each student. As a result, they adapt the teaching process at any time to meet that unique combination of moods, characteristics, and needs. Furthermore, they become convinced that having that instinctive feeling for students is simply *good teaching*.

However, while that instinct can help, what increases the effectiveness of a learning process in traditional education is the dynamics that take place in and around the classroom. Teachers do not seem to realize that most learning interactions occur outside of the classroom, whether in spontaneous discussions between students, between students and a teacher or between students and their family environment. It must be accepted that students also learn when they meet informally in the cafeteria, or while discussing issues related to general topics. What is certain is that they can learn more in these spontaneous communication activities than while they are *lined up* for a classroom lecture.

As a result of this, many teachers do not feel confident in playing the role that is expected of them in virtual education, and they fear that they will not be able to *teach well*. All this can be solved if they accept that the key role of communication is played by technology because it is the link between them and the students, so they must develop management skills that allow them to use them effectively and efficiently in the development of the learning processes. In addition, the teacher needs to understand the strengths and weaknesses of each technology and practical strategies for using it in the virtual classroom.

The point is that teachers are used to the transmissionist model of traditional education where, through lectures, they transmit knowledge to students, who memorize it and then, in a way, demonstrate that they have learned by *regurgitating it* by answering the so-called standardized tests.

The problems with this model are that it does not take into account that each student learns differently, it is based on passive learning with little or no socialization, and there is no way to verify and validate the degree of depth that the student experiences in his or her learning. learning. In this age of technological revolutions, people, regardless of their age, are social and perceptive creatures who prefer to learn through experiences; they need to work as a team, sharing and collaborating on projects; and they learn and retain knowledge better when they perceive learning as practical, situated, and applicable to everyday life.

In virtual education, the communication between the teacher and the students undergoes a wide transformation, because it is lived as a generative process where everyone learns from everyone; that is, they learn together in a collaborative work process in which one role does not predominate over the other, because they are all learners. In this way, each project generates active learning, which pushes the frontiers of knowledge and generates innovation. The teacher designs a teaching model and didactics that challenge students and keep them alert to identify knowledge in all activities of the learning process.

In this context, the teacher becomes a modeler who, through constructive discourse, *negotiates* the meaning of the information with the students, a role that builds knowledge and innovation in a kind of learning community. In this new educational environment, what causes the most fear among teachers is that they give up *control* over the learning process because they need *to trust* and *learn* that students learn with or without their presence in the learning process.

Also, they create or model an environment that encourages students to take responsibility for their learning, so they need to change their teaching approach. In this way, they go from being simple information disseminators to learning facilitators-advisors; that is, to support and guidance mentors, for which they put their experience and knowledge in each topic at the service of the learning process, creating a common pattern of interaction and mutual support in the virtual classroom, in which they must:

- Encourage students to articulate their learning needs.
- Provide an open space in which collaborative work is promoted.
- Participate in knowledge discussions.
- Verify and validate learning through self-assessment and consensual agreement.
- Share the successes and mistakes of the development of the projects with the whole class.
- Keep a file of knowledge discussions and interactions and solutions that students present, as well as your own.
- Attend and intervene in all moments of conclusion and definition of knowledge.

This new role requires them, in addition to knowing the content, to have experience in the industry and knowledge of the method to design the teaching model and didactics that help students achieve learning outcomes. That is why they develop skills as a designer of learning processes, animator of discussions, and evaluator of learning results; without ignoring that he also has to be a conductor of situations, animator of the environment in the virtual classroom, and a *therapist* attentive to the needs and requirements of the students.

As if that were not enough, they must have technical skills and know how to adapt content, facilitate access to information, expand knowledge and communication, and promote critical reflection and argumentation in the classroom community. It has the task of verifying and validating the reliability of the practical project and of evaluating the achievement of the learning outcomes. In other words, the virtual teacher is an instructor, facilitator, moderator, and animator, but, above all, a point of reference for students.

So, a question arises: if the new technologies and virtual activities have the potential to be true agents of educational transformation, why has traditional education remained stubbornly resistant to change? A logical answer is that the institutions use them only as an added concept to the way they educate since the 19th century, leaving the fact that the best place to start the change and potentiate its use is the teachers, both those who are in training as well as those who already practice the profession.

Virtual education is a paradigm that is revolutionizing the educational system, not only because it takes advantage of technology and discoveries in the field of cognition, but also because it moves away from the rusty dominant academic theories and reconsiders the roles of institutions. , the study plans, the contents, the classrooms, the students, and the teachers. But this seems not to be in tune with the idea of controlled and centralized education offered by the education system; where teachers are the *wise*, *experts* and *protagonists* of the system, and the knowledge that students have to learn revolves around them because there is no other way for them to learn. If not, why is it that education faculties still do not offer programs aimed at educating and training teachers for virtual education?

Teacher education and training in colleges of education provide them with considerable experiential learning to take into the classroom, but they must develop a broader point of view and have opportunities to reflect on their teaching practice, both individually and in groups; broaden their understanding of the relationship between their classroom activities and accepted and developing theory; complement your studies with topics such as legislation, guidelines, theory and practice about education; and be attentive to explore new developments or resources that help them specialize in each discipline.

Teachers must also be trained about the multidimensionality and transdisciplinarity of the act of educating because this knowledge will influence the structure and content of each learning process that they are responsible for advising. They should be aware that educational considerations do not exist independently of each other, so they need to cross-reference learning tasks and material in all contexts. Also, learning that the knowledge they impart or discover is retrieved and applied in real life, so teaching should be structured using project-based learning and highlighting the interdependence of situation and cognition.

Faculties of education must educate and train teachers to translate their knowledge base and improve their delivery to students, from a predominantly coaching orientation to a predominantly teaching orientation. But without forgetting the use of technology, because the nature of the technology used in virtual education for teaching and learning guarantees not only that the teacher is aware of the potential of the variety of sources of stimuli and information for himself and their students, but rather that they can take advantage of it in the learning process.

This also applies to teachers who have been practicing the profession for some time, since their teaching model is based on a traditional instruction method and the institution is expected to design a re-training process so that they develop the skills that require virtual education. Do not wait for them to change their role from information distributor overnight to that of facilitator and tutor. In addition, in the virtual education environment, students are more independent and have access to an overwhelming amount of information, so it is essential that teachers guide and advise them to properly decant and use this ocean of information.

Likewise, people have a life experience that should be cultivated as a resource for learning, and not cataloged, as traditional education repeatedly does, with the simple label of *informal education*. The professors also have their own experience, which they channel, together with their knowledge, to carry out the personalized advice that students require. In more practical words, the teacher shares what works and what doesn't, but is obligated to provide students with the resources and enable them to learn by integrating their life experiences with new information and constructing meaning. This is achieved through experimentation and, although everyone is going to make mistakes, the teaching model emphasizes that you also learn from mistakes, so the presence of the teacher is to facilitate the learning process, not to tell them how to learn.

In the New Era, learning is linked to what students need to know or do to integrate as professionals and to develop the functions and responsibilities that society demands. But it turns out that not all virtual students have the same level of knowledge about the contents of a learning process, so the teacher needs to recognize them and motivate them to form teams according to said level and, from there, assign them differentiated projects.

Students with a lower level of knowledge need more accompaniment and advice, in which case the teacher uses *advanced students* to assume the role of advisors, in such a way that a collaborative work climate is fostered to achieve the results of learning. Another option is to challenge students to formulate the project in which they are going to experience the knowledge themselves, which requires them to understand and comprehend the contents and to know how to use the knowledge.

Learning is undoubtedly influenced by the interactions that occur in social relationships between people because in this dynamic, collaborative work communities are built among which relationships generate learning as a social phenomenon, rather than an individual one. In the New Era, education is an interactive process in which students and the teacher work together to build knowledge while developing projects, an interaction in which everyone collaborates and shares until the knowledge with which they achieve learning outcomes are specified.

In these collaborative learning environments, teachers recognize the difference that technology makes in their role as designers of learning processes, in addition to assuming the role of interaction facilitators, instead *of knowledge oracles*. But for many institutions, and even for the education system, it seems that the most important thing is to focus the change on the teacher's role as a designer of learning processes. To achieve this, they forget that they need to develop skills to promote interactions in the virtual classroom, thus generating useless virtual teaching-learning environments, because once the learning process is designed, the teacher sits and passively waits for the students to demonstrate, instead of actively participating to promote and encourage effective interactions to share information and knowledge.

The common belief is that just using technology is enough to make interactions happen spontaneously, and while some do happen this way, it's more likely that they won't happen in the way the group needs them to. The reason is that the relationships and conditions in the group, such as social cohesion, shared cognition, and collective effectiveness for the development of projects, are what determine how teachers and students can work together to collaborate and share information.

Another widespread question among teachers with the advent of technology and its appropriation in education is whether they should devote time and effort to learning and implementing new teaching models and didactics design. The point is that with the responsibilities they assume in traditional education, they already feel overloaded with obligations in their functions. Therefore, they now feel that more obligations are being added to them, even if it is for their professional development. The solution is for the institution to show them the potential benefit, of value, and with enough probability of it happening, that it justifies the time and effort they need to spend.

This is not a motto that applies to everyone and in all circumstances, because it is within each one. That is if the teacher is responsible if he chose this profession because he was born and has a vocation, and if he does not practice it simply because he could not find what else to do, it is almost certain that he has deep dreams of how to be a better teacher. This is where virtual education comes into its own, because, unlike traditional education, it allows teachers to dream their dreams

and have a realistic hope of making them come true, and you can hear more of them say that it's worth investing in learning to make the idea of being a better teacher come true. The reason is that in this virtual educational model teachers can:

- Apply and use what they know and learn in simulated real situations.
- Find ways to improve daily and make a difference.
- Develop a deep curiosity and share it with students.
- Participate and help others to achieve learning for life.
- Experience the joy of seeing students achieve learning outcomes.
- Take pride in what they do and can achieve, in any discipline or line of work.
- See the importance of teamwork, because that's how you work in real life.
- Discover the connections that exist between their beliefs, values, and actions with those of others.
- Think about problems holistically and develop projects to solve them in a collaborative and shared way.
- Find connections between multiple dimensions and disciplines.
- Identify change needs and be a change agent.
- Develop creativity at higher levels.
- Develop abilities, skills, and abilities for life.
- Understand and comprehend knowledge in each learning process.
- Grow as people and critical thinkers.
- Assess continuous improvement processes.

However, this may not be enough for teachers to decide to start retraining to become better at what they do, and many still have important questions associated with the process of making substantial changes in the way they teach, for example. example:

1. Is it possible to change my teaching model so that students better achieve learning outcomes? The answer is yes, and this is validated only by doing a rational search to discover that other innovative and supportive teachers have already done it.

2. But can I do it, because it's such a tremendous challenge to change the way I've been teaching my whole life, and changing myself sounds hard enough? The answer is yes, and while it is difficult to change ingrained behavior patterns, you must remember that it is not about changing everything, just a few things. Also, changes are part of people's lives and some are intentional.

3. How do I know if I have changed the way I teach? The answer is that you can see it in the behavior of the students, their participation, their commitment, their dedication, and their motivation. In addition to being reliable proof that your teaching model has changed, you will feel that there is more empathy and collaborative work in the group.

Innovating the teaching model makes a real difference, both in student learning and teacher satisfaction, however, institutions need to provide them with more support and recognition. Everyone must approach the process as an improvement project in which teachers need to:

- *Awareness*: of their own need to learn and change, and of their need to support institutional changes that impact the educational context.
- *Encouragement*: Knowing that others value your professional development and your ability to innovate teaching.

- *Time*: necessary to learn and to innovate its teaching model and didactics.
- *Resources*: access to consulting services, work teams, materials, workshops, and conferences that provide them with the intellectual and emotional resources necessary for innovation.
- *Cooperation*: of students who understand and are aware of what constitutes good learning and good teaching.
- *Recognition and Reward*: Being formally recognized and rewarded, both for the effort to improve and for the successes they achieve.

As institutions recognize these needs, they learn to operate in an increasingly competitive environment, as they begin to think more about the educational needs of society and seek better ways to meet them. In addition, good teaching promotes better learning and all education actors need to know this since this determines how they respond to social demands and needs. Hence the importance of structuring a perspective in which teaching and learning are related to improving people's quality of life.

Much of the research in education about the abilities, skills, and abilities that teachers need to practice in virtual education refers to those that are required to perform a specific role. Although many skills are intrinsically linked to specific roles, teachers share with their colleagues the responsibility of imparting learning processes and advising groups at different educational levels, therefore, they need to be trained to adequately attend to each situation. Although it is not yet possible to find a consensus regarding the abilities, skills, and abilities that teachers require to perform in this way, Table 3 below describes the roles and abilities considered general in virtual education.

Table 3. Roles and general skills of teachers in virtual education

Role	Abilities
Managerial	Manage time and the learning process; leadership, setting rules and regulations; follow efficient administrative and management procedures; maintain permanent contact and dialogue with colleagues and the administration.
Academic	Use an appropriate approach to adapt to the technology; organize and promote different modalities of advice; organize and facilitate student participation; link each topic to real-life scientific, social, and cultural phenomena; verify and validate learning outcomes; use the digital classroom as a space that facilitates learning; apply and guide collaborative, active, constructive, reflective, authentic and project-based learning.
Social	Maintain a cordial learning environment; resolve conflicts amicably; refrain from undesirable behavior; act as a facilitator of information and knowledge; improve the learning environment; support student initiatives; provide timely feedback on the results of each project and evaluation; encourage interactions and communications between students; Keep the administration informed about the progress and possible drawbacks of the teaching-learning process.
Technical	Technical capacity to develop content and adapt it to the environment of the virtual teaching-learning environment; adequately use virtual platforms, resources, and tools; Support students in the management and use of technology.
Adviser	Verify and validate the work of the students according to the established criteria; monitor individual and group progress; evaluate individual and group performance.
facilitator	Design the teaching model for personalized learning; encourage creativity; respect different types of students; adapt to the needs of the student; Recognize different learning styles.
content provider	Maintain updated content to facilitating learning; select and use the appropriate material for the achievement of learning outcomes; Design hands-on learning activities.
Investigator	Maintain a searching attitude about technological and educational developments and interpret and integrate the results into learning processes.

This should be enough to accept that the role of teachers has changed, especially when the development of their professional practice goes from the traditional classroom to the virtual classroom. In addition, in this environment, they need to develop new abilities, skills, and abilities, because, at the same time, the students have also changed. The goal of all involved in the learning process is to examine how to play changing roles and the associated skills. Likewise, institutions

have a responsibility to investigate what teachers require and provide them with the necessary training and support so that they can innovate their teaching model and adapt smoothly to the new educational environment.

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4. TOOLS AND TECHNOLOGIES FOR VIRTUAL EDUCATION

The tools and technologies for virtual education are complex constructions that in themselves are considered the body of knowledge and structure of virtual teaching-learning environments, being part of the process as well as a product of it. However, virtual can be an illusory concept with multiple meanings, so these environments do not always involve digital technologies or tools to be considered virtual.

The estimation that computers are the only necessary and sufficient criterion for designing a virtual education environment is a confusing element of the equation and, as a misunderstanding, it must be understood that technology is not just the sum of artifacts, wheels and gears, rails and electronic transmitters, because it is a system and, as such, implies organization, procedures, symbols, new terms, equations and, above all, mentality [64].

The mindset idea suggests that virtual reality is a concept of the imagination because it makes possible the modeling of human experience. Likewise, there are a variety of tools that are harnessed in imaginative learning environments, such as talking, listening, writing, printing, static and moving images, and music, which stimulate students' imaginations. This involves earlier technological developments, such as the printing press, pen, and ink, photography, film, radio, and television, among others.

In the educational environments that arise from the fusion of these tools and technologies, different types of virtual experiences underlie, so it is necessary to differentiate between virtual learning and virtual learning. Virtual learning is experienced in virtual teaching-learning environments mediated by computer technologies; while virtual learning is a much broader term, reserved for contexts in which the imagination is developed, where a wide range of media and contexts are used to create meaning. However, from an educational perspective, both environments are subject to similar criteria for learning success, although some criteria may be more appropriate for one than the other.

With ever-developing technology and associated tools becoming widespread, there is concern that virtual reality for learning and the creation of virtual environments will outstrip the capabilities of the tools. While the existence of an application does not in itself guarantee expected success, many of its features guide in the direction of where and how to leverage its potential. Therefore, the use of technology in education is not considered in the abstract, because it requires an understanding of the educational landscape in which it will be used.

It is common for institutions wishing to implement virtual education to begin the process by first selecting the tools, then determining the academic part, which will result in learning processes dictated by the technology, where it becomes a kind of tool to enhance them. What is needed is an early understanding of the tools before determining the need for technology, and from there begin to structure and develop the learning processes. The tools and technologies that are selected should reflect the specific environment of the virtual teaching-learning environment, the technical capabilities, and the strategic plans for the development and growth of the system that the institution has or desires.

This educational innovation does not respond only to a planning strategy designed by the administration or the owners of the institution. These decisions are the result of broad

organizational planning, supported by improvement plans structured based on accurate information, analyzed, and discussed by the institutional bodies. The reason for this is that, given the pyramidal structure of most educational administrations, many superior decisions are imposed, without attending to or incorporating the actors directly responsible for education; that is, the lower part of the pyramid. The response of these actors to these impositions can be negative and lead to the initiative having no future, even if it is well structured.

4.1 TOOLS FOR VIRTUAL EDUCATION

Until the end of the 20th century, the education system was presented as the main (for many the only) options for transmitting knowledge, that is, for educating. But in the new century and thanks to technological developments and discoveries in neurocognition, the physical presence of this system became immaterial. And although the advances and developments of this century alter people's perception of how knowledge is acquired and demand a thorough review of how the teaching-learning process is approached, the education system remains lethargic and does not seem to realize that it needs a total revolution.

Even in the New Era, education is a conservative area that seems not to want to interpret the signals sent by society since it began to use technological tools, simulators, and trainers and to attend virtual learning processes, which provided new opportunities to acquire knowledge and to develop new skills. At the same time, some people learned to improve their concentration to perform complex, creative, and analytical tasks, because from technological development emerges a more specific and expanded form of education, in which it is not necessary for the student to adapt to general schedules, nor to be locked in a classroom where he/she is treated as one more in the middle of a *group of peers*.

This new educational context creates an environment that easily adapts to the needs, demands, characteristics, and individual needs of each student. At the same time, educational support tools emerge and are refined as institutions and innovative teachers use them in virtual education teaching models. Some of these tools are described below.

4.1.1 Expanded education

In the 21st century, distances are no longer an inconvenience for education, because people learned to study online anywhere in the world while moving away from traditional education based on the physical classroom. Globalization in the New World Order made the planet change rapidly and generated spaces where people connect to be trained in more and more specific and practice-focused subjects, where they take advantage of schemes that allow them to train and work at the same time. This scenario, apart from being a springboard to independent living, made workers realize for the first time that education is a continuous process that spans their entire productive life. This new training and education environment is called *expanded education*, an innovative concept that transcends the barriers, taboos, and limits of traditional education. It is also a real option to overcome the shortcomings of the education system.

Expanded education is conceived as an educational modality that combines elements of traditional education and informal knowledge with the use of technologies to make lifelong and life-wide learning a reality. It is a teaching-learning process with advantages such as easy access, search capacity, interaction, powerful support for effective learning, and performance-based evaluation.

Research related to expanded education is under development and it is expected that institutions will assume it as part of their structure and program offerings because it is a powerful tool that in virtual education is used to design learning processes, curricula, and innovative content, oriented to meet the demand for new skills, abilities, and capacities of the productive sector.

Expanded education materialized a discussion that had been brewing for a long time in the corridors and corners of traditional institutions: recognizing that students learn more outside the classroom than inside it. With the development of technology and networks, this premise became more evident, because people have access to enormous amounts of information, while at the same time, they are interconnected and can analyze, discuss, pool, and share knowledge. In addition, learning communities with high cognitive value are created. In one way or another, this tool is vital for students to learn through their experiences outside the classroom, where they use technology to relate to the world and follow principles such as:

- The boundaries between formal and informal education disappear because expanded education is based on an educational model in which learning takes place anytime, anywhere.
- Learning processes are more efficient and effective because they are developed in a collaborative work environment, where knowledge is not *stored* in a specific place and where its exchange is interactive and open.
- The student is the active agent and responsible for his learning process, so he is motivated to understand and comprehend the knowledge he has access to.

In the New Age, the school is losing its *monopoly on* education, creating at the same time an environment in which it is necessary to analyze its fundamental *modus operandi*: *the pedagogical model*. A widening gap has also emerged between this model and the natural way people learn. The traditional classroom model based on the old-fashioned lecture, teacher-centered, unidirectional, one-size-fits-all, and with a student isolated from learning, contrasts with the world in which students are born and grow up, i.e., an interactive digital world in which they learn in all their relationships.

These students are restless, want to ask questions, do not trust adults, and want lively two-way conversations, not a static lecture. They expect an interactive education that they feel responsible for and involved in, not a transmissionist education founded in the early 19th century. Because they grow up in the digital world their minds work differently, they can multitask and have adapted to living surrounded by information overload, so they are encouraged to be active and demanding researchers, and instead of waiting for a teacher to tell them what is going on in the world, they take the initiative and seek it out on their own.

Hence the statement that the school is losing its monopoly because, in the 21st century, the web inexorably becomes the dominant oracle of information and knowledge, where it is possible to consult as well as share it. As if this were not enough, educational institutions devote most of their resources to research, not academia, slowly turning into science and research institutes. Academics are becoming a secondary function, to which institutions pay attention only when they need accreditation to stay in business.

One issue that serves as an indicator of what is happening in education is that most institutions offer programs with no labor market, and continue to develop skills for which there is no longer a demand. The reality is that the New World Order demands a fundamental restructuring of the education system away from what Marc Tylor called *ultra-narrow scholarship* [65]. Higher

education is required to structure and offer programs to train people and train professionals to solve the problems of the next decade, but with a sunset clause, because if it continues to undervalue expanded education, the time will come when people will no longer need to attend a formal institution to develop the skills, abilities, and capacities that will qualify them to perform efficiently in the productive sector.

We must begin by recognizing that the traditional pedagogical model does not work because it is not appropriate either for the New Era or for the new category of students. The premise that: *I am the teacher and I have the knowledge* is no longer valid. *You are a student, you are an empty vessel and you do not know. Get ready, here it comes. Your goal is to get this data into short-term memory and, through practice and repetition, build deeper cognitive structures so that you can remember it when I test you* [66]. All of this is summed up in one simple sentence: *educational institutions should be places to learn, not to teach*.

This situation is not new, because the classroom as a *temple of learning* has undergone a massive transformation in this century, and not because it has screens, mobile chairs, round tables, or digital boards, but because the students who occupy it have interconnected digital artifacts, with which they access massive volumes of new information. Thus a context has been generated in which almost the entire body of human knowledge flows in, through, and around that classroom. In this immense cloud of ubiquitous information, students discover and create information, which they share through discussion and participation without the intervention of a dominant authority.

This expanded education environment is a disruption to the traditional pedagogical model because as students live in a universe of instant and infinite information, the importance of knowing, memorizing, or remembering decreases, and the need to develop skills to find, order, analyze, share, discuss, criticize and create knowledge is strengthened, in a constant commitment to be well informed.

In hyperspace, information is also qualitatively different from that stored in other forms because people can create, manipulate, read, criticize and organize it to present it in ways that are limited only by their imagination. But in expanded education, time must be taken to understand the true potential of information and to analyze other related dimensions that emerge in it.

Technology offers people new ways of relating, communicating, interacting, sharing, exchanging, and collaborating, which enhances the usefulness of information as a source of knowledge, because it is experienced in an interactive, participatory and collaborative spirit, which are very important characteristics in education. This is why the revolution that has been taking place in education since the beginning of the century is social, not technological.

Technologies are the means and their benefits will not be realized unless it is first recognized that traditional education is in crisis. If the education system continues to look to technology as the solution to its problems, it will only magnify them. The recommendation is to use expanded education to work with students and address problems that are real and meaningful to them, in such a way that they are coached to discover the necessary knowledge and achieve the established learning outcomes.

The pedagogical model centered on the teacher and on what students must learn forgets the how and why of learning, while expanded education takes advantage of the universe of information to reverse the sequence because first the *why* is addressed, then the *how* is facilitated, and the *what* is generated naturally. To achieve this, it is necessary to rethink curricula, content, teaching

models, and didactics; furthermore, content should not prevail over form and learning processes should stop revolving around topics. The curriculum of traditional education is structured in subjects and topics, which the student takes, and when he/she finishes, he/she is convinced that he/she does not need to retake them because he/she has learned them.

This belief is far from reality because the same volume of information to which students have access will show them that they know nothing and that they have to learn how to learn for life. Learning processes should be subjectivities with which students re-acquaint themselves with different ways of approaching, understanding, and interacting with the world. But since subjectivities are not taught, students must be made to unlearn the perspectives they consider fundamental to their identity. This is made possible by expanded education, as students look to technology for new ways to collaboratively re-skill themselves so that these subjectivities can be seamlessly realized.

The traditional education system does not seem to want to attend to the demands of the Information Society in the New Era in terms of its progressive clogging and continues the useless instrumentalization of technologies to cover the crisis it is going through. In this way, it ignores the needs and demands of the new category of students, the importance of information to generate knowledge, and the irremediable emergence of learning. Expanded education is a valuable tool for education in general because it values and takes advantage of the fact that students use media and technologies in all their activities, and to be together and express themselves and expect them to be part of their education and training.

4.1.2 Challenge-based learning

In this century people use technology to access information, from which they manage the acquisition of knowledge in processes of so-called informal education, and have become, in addition to consumers, generators of information. This is an important detail in which traditional formal education seems not to be interested, resulting in a model that is not appealing to students, because it is less and less effective in engaging and motivating them to achieve learning outcomes.

To address this deficiency, virtual education has the tool of *challenge-based learning*, an attractive transdisciplinary approach that involves students in the learning process takes advantage of the technology with which they live most of their days, and guides them to solve complex real-world problems. It is an educational framework based on collaborative and practical work, where students analyze and discuss with peers, professors, and specialists from around the world, to generate deep knowledge from the learning processes.

Being transdisciplinary, cooperative, and applied in nature, challenge-based learning is a way to get students' attention so that they become involved and assume their role in education. In addition, it simulates the workplaces in which they will practice as professionals. In this teaching-learning context, teachers work collaboratively with students and coach them to find and use transdisciplinary content, to relate it to what happens in real life so that they understand and comprehend it. It also provides the structure, support, checkpoints, and tools for students to do their work while giving them the freedom to learn in a self-directed, creative and inspiring way.

The education system is failing to overcome its shortcomings and is not succeeding in keeping students in school, and the evidence shows that one of the main reasons they are dropping out of the system is because they do not feel valued and do not identify with the static, old-fashioned model of traditional education. While other factors cause them to drop out of the system, mostly

related to family problems, it is increasingly evident that the most important factor in making this decision is that they feel that what they are learning is not relevant to their personal lives, much less to their work lives.

Something has to change, and challenge-based learning is seen as one of the solutions to be implemented. Students re-know and understand the problems of their environment, but also those of the world and, although they do not show it, they are aware that the planet is going through a dangerous and delicate situation; they realize that temperatures are rising; they know that humanity's lifestyle is based on non-renewable energies, with all that this implies; and they understand that there are real problems to solve and that they can collaborate to achieve it. But, despite all this, they realize that the system is not training them to face these problems, so many of them decide to leave it.

For several decades this topic has been mentioned again and again in the specialized educational literature, although the educational system does not pay the necessary attention to it. Over the years many teachers have tried to adapt their teaching model to this reality, but institutional regulations do not allow them to evolve, because instruction still revolves around lectures focused on content included in tests. Challenge-based learning is a practice that brings students together to solve real problems, using real resources and applying appropriate knowledge. It is a didactic that awakens students' curiosity and desire to learn, so it should be at the center of the curriculum, giving students the ability to use technological tools, challenge themselves, and work collaboratively, but at their own pace.

In this way, students focus on a challenge and create a space in which they conduct their research on real-world problems, and think critically about how to apply what they learn in each learning process to solve them. The teacher's role changes from delivering information to advising the construction of knowledge, and students identify and refine the problem, define research questions, use technology and material from the learning process to investigate the issues and sort through possible solutions until the most reasonable one is identified.

For these reasons and although the results are unimaginable, challenge-based learning is a simple and powerful idea that has proven to work to innovate the teaching model. Some validated results in the application of this tool are:

- *Helps develop the skills needed in the New Age*. Including leadership, creativity, media literacy, problem-solving, critical thinking, flexibility, and adaptability.

- *Motivates students to be protagonists of their learning*. At the end of a learning process, students demonstrate the achievement of learning outcomes at a high level, in addition to others that were not established.

- It *helps students engage in education, understand and extend the material, and make the most of the time.* They understand and comprehend the material in the learning process while being committed to making the most of the time they spend learning.

- *It is convenient for empowering virtual education*. Taking advantage of students' mastery of technology environments, challenge-based learning demands a little more from them each time, because, in the process of project execution, they have to navigate a wide variety of environments.

The axis of challenge-based education is the challenge, which makes students look for ways to make something happen, because they are motivated to research the topic, generate ideas about how to work and propose solutions supported by resources and discussions, and select and develop the one they consider most appropriate.

As shown in Figure 4, the process begins with the presentation of an important idea, which generates a basic question in the students; from there the challenge is structured, which will necessarily generate new questions and the definition of the activities and resources needed; then research is conducted to determine and articulate several solutions, from which one is selected for implementation and evaluation; at the end, the result is published and shared with the community. At all times students are reflecting and evaluating progress, alternatives, and the pros and cons of their process, which helps reinforce their learning and prepares them for professional practice.

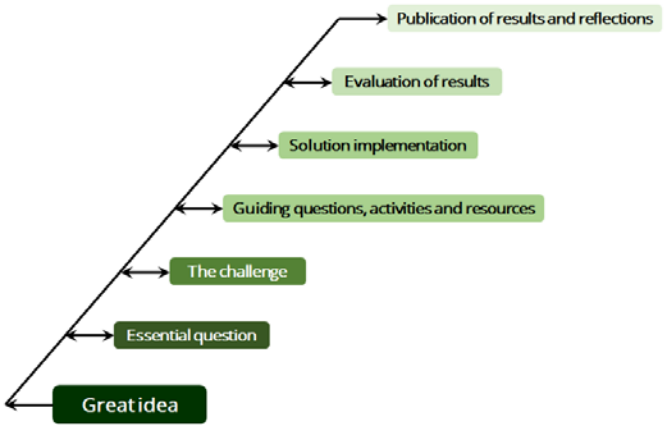

Figure 4. Process of challenge-based learning (Adapted from [67])

This model is a response to the growing concerns of society and employers that students do not adequately develop abstract thinking and systems thinking, that they do not solve problems as expected, that they do not know how to work in teams, and that they do not learn for life, but for a test. This tool promotes creativity and informed decision-making, enabling them to develop the skills they need to perform as professionals in the New World Order.

On the other hand, challenge-based learning is a tool that facilitates students to learn and develop themselves, and encourages them to reach their maximum potential; it involves teaching-learning models that motivate them to use diverse technologies and to carry out activities based on their skills and interests; also to act based on the knowledge they discover and to exchange information and experience teamwork.

Another important feature of challenge-based learning is that it appropriates networking tools and media production techniques, which students use daily, and provides them with an opportunity to hone skills in communication, leadership, civic literacy, and social responsibility, among others.

4.1.3 Project-based learning

The education and training that society demands of professionals are an aspect that must be considered in the design of any educational strategy, but the rapid technological, economic, social, cultural, and political changes of the New Era are constantly defining new employee profiles that companies need. Technological knowledge alone will not solve the problems of the industry; a

solid human education is also needed. In addition, since innovation and flexibility are at the forefront of the New Era, skills such as creativity, initiative, and risk management become relevant.

Entrepreneurs point out that education does not develop research and creative skills in students, because the model is excessively theoretical, imparts very general knowledge, with deficient specialization and low updating, and that professionals have little preparation for working in teams. In the New World Order, the concept of a *specialized professional* is the basis for meeting the business demand, so the development of new skills is a key element of any teaching model.

Due to the speed of technological developments and their impact on globalization, in this century companies changed the concept of competent professionals for specialized professionals, because they realized that for the new jobs, they needed people with specific knowledge and with a lifelong learning mentality. Therefore, they request employees who have developed transversal skills, such as communication, information management, problem-solving, teamwork, and leadership for social processes, among others.

This new general framework for employment increases the need for education to innovate the process of education and training of students, and *project-based learning* emerges as a tool to develop these skills. The objective is to design learning processes where students are more than passive receivers of knowledge, and seek to build it from what they learn and experience, and share it through collaborative work and interaction with others.

Generally speaking, project-based learning is a student-driven and teacher-facilitated approach. Students want to learn by asking questions about issues that spark their natural curiosity, a key element in this approach, and teachers coach each step of the process and discuss each option with students before making a search decision. Students with similar concerns are organized to work cooperatively, encouraging the development of collaborative and communication skills, but respecting individual learning styles and patterns, and preferences.

According to the characteristics of the new category of students, project-based learning is not a complementary activity, but the basis of the teaching model. Because the inquiries are science-based or originate from social problems, reading, writing, and calculation activities are included in the project, resulting in better comprehension, deeper learning, higher-level reading, and higher motivation for learning. In addition, project-based learning is key to developing critical and independent thinking skills, because students solve real-world problems by designing their inquiries, planning their learning, organizing their research, and implementing their learning model.

Project-based learning is based on three principles: 1) learning is context-specific, 2) students are actively engaged in learning, and 3) students achieve their goals through social interactions and knowledge sharing. The core of this initiative is that students demand opportunities to construct their knowledge, and in projects present solutions to real problems; through questioning and refining; designing and conducting investigations; gathering, analyzing, and interpreting data and information; reaching conclusions, and reporting results.

That is why this tool is the appropriate complement to challenge-based learning because they integrate harmoniously: on the one hand, challenge-based learning allows students to encounter real-world problems and project the benefits, risks, and negative aspects of any possible solution; on the other hand, project-based learning enables them to understand the problems, improve knowledge about a topic and structure a work plan to solve them.

Project work is a form of collaborative learning in which participants contribute jointly to the achievement of the outcome, and experience experiential learning with active reflection and conscious engagement, rather than the simple passive experience of a lecture.

By solving design problems and constructing the project, students experience freedom, which translates into improved levels of participation and strong affective, ethical, and aesthetic dimensions that facilitate learning. In general terms, project-based learning is characterized by:

1. *To be the center of the curriculum and the teaching model*. That is, teaching revolves around the project, in which students encounter, learn and apply transdisciplinary concepts.

2. The objective of the project is to *motivate students* to find the concepts and principles necessary to understand it. The teacher advises and seeks to make that definition oriented to establish a connection between the activities and the underlying conceptual knowledge to be fostered. Questions, activities, products, and student performances are directed in the service of an important intellectual purpose.

3. *Engage students in constructive inquiry*. To be considered a useful project for learning, the core activities must involve student discovery, transformation, and application of knowledge.

4. *Incorporate greater autonomy, choice, unsupervised work time, and* student *responsibility.* Projects are not selected or directed by the teacher, nor do they end with results or take predetermined paths, i.e., they are built based on progress.

5. *Be realistic*. The project incorporates features that give the student a sense of authenticity, such as the topic, the tasks, the roles to be played, the context in which it is carried out, the collaborators, the products, the audience, or the criteria by which it will be evaluated. The project revolves around real-life challenges and authentic problems or questions because the solution has the potential to be implemented.

The project-based learning tool is innovative because it emphasizes cooperative learning and because students achieve tangible results to represent what they learn. In addition, it allows a diverse range of outcomes to be achieved that supports multiple solutions, rather than a *single correct answer* obtained through a standardized test and predefined procedures. Therefore, the project needs:

- Being organized around a problem or challenge without a predetermined solution.
- Create a need-to-know essential content and skills.
- Allow students to design the process to arrive at a solution.
- Require critical thinking, problem-solving, collaborative work, and diverse forms of communication.
- Provide the opportunity for students to examine the process from different perspectives using a wide variety of resources, relevant information, and management of the information they collect.
- To ensure that students learn to work independently and take responsibility when making decisions.
- Have students regularly reflect on what they are doing.
- To achieve an end product, necessarily non-material, which will be evaluated for its quality.

- Create a context in which error and change are tolerated.
- Changing the role of the teacher from leader to facilitator.

This way of working in virtual education means that the teacher is no longer the main source of knowledge, because students have access to specialists and a large volume of information, and discover new and relevant knowledge that the teacher may ignore. The experience of challenge-based learning is that students take on informal and formal roles as tutors to their peers and, in many cases, teachers. It is therefore a tool to materialize the premise that in education in this century, we all learn from each other, because the teacher's role is to tell students how to question and develop hypotheses and strategies to find the required information, and becomes a partner in learning, as students can formulate projects in territories unknown to him.

Likewise, the technological development and discoveries in neurocognition of this century are triggers for the education system to innovate and to make the quality-quantitative leap to train people and professionals for the New World Order, in which the economy is based on knowledge to respond to the challenges of globalization. However, this has not yet been done and there is no strategic starting point to achieve it.

In the educational model required in the New Era, the incessant search for truth, in which the teacher teaches what he discovers and learns day by day, subjecting his knowledge to permanent analysis and contrast by the students, is an issue that must be altered. The development of the skills needed by professionals is a fundamental aspect that must also be considered in the design of any learning process. Because, although there is consensus that students need more than basic knowledge to perform as professionals, there is a feeling that traditional education does not meet this need.

Much of what teachers, families, institutions, society, and employers want a professional to do tends to fall through the cracks of traditional learning processes and teaching models. Some teachers try to teach, for example, critical thinking skills, but many do not, and even if the opportunities are provided, they are often implicit or assumed to be embedded in a specific task or activity. A good project thought out, designed, and executed by the student brings it all together. In a well-implemented project-based learning initiative, students develop not only formative skills but professional training skills, because they are explicitly taught, assessed, and asked to reflect on their learning.

This tool complements challenge-based learning because the student learns to identify the challenge and appropriates the information and knowledge to understand and comprehend it, while in project-based learning the student learns to structure the process that culminates in the implementation of a solution. The challenge must be identified in each subject that the student takes, and the project must integrate the learning of all subjects so that the student re-conceives that what he is learning has a practical utility of social benefit.

4.1.4 Ubiquitous learning

Since the end of the last century, the world has begun to shift rapidly from an industrial to a knowledge-based economy, and as physical boundaries are broken down, digital technology is becoming more global and diffuse, generating a global context in which human nature itself is defined by people's ability to consume or produce knowledge. Given the nature of information, and how and by whom it is created, the spaces in which it is found evolve rapidly, because

technology makes it possible for it to be produced and disseminated. Therefore, learning can occur *at any time and place*, a notion that has been termed *ubiquitous*. Technology then emerges as a tool to obviate distances and time, combining real and virtual worlds, and reaching all social spaces of the New Age. This growing prevalence of activities and means of constructing and disseminating information necessarily involves the idea that students can learn about anything and experience that learning at any time and place.

This ubiquity arises thanks to the significant increase in the development and use of digital technologies because these devices offer the opportunity to integrate learning activities into the daily lives of people around the world. This creates a learning context whose main characteristics are permanence, accessibility, immediacy, and interactivity, which eliminates the limitations of the physical space of the traditional classroom and facilitates personalized learning supported in virtual teaching-learning environments that immediately affects what, how, where, and when learning takes place. Likewise, this ubiquity offers people new opportunities to satisfy their individual learning needs.

A revolutionary tool for education called *ubiquitous learning* emerges, which improves student motivation, performance, and attitude towards learning. Given the characteristics of the new category of students, in the sense that they are highly adaptive, teachers support their teaching model and build knowledge through interconnected learning activities and in various real-world contexts, which currently seem hidden in traditional education. But without leaving students alone, because although they have ample mastery in the use of technologies, they need advice and accompaniment to learn meaningfully and in the right place, at the right time, and in the right way.

This ubiquity allows the achievement of learning from formal, informal, and social educational contexts, which makes it suitable for students of this century because they learn to learn for life and to potentiate their nature to explore, identify and make the most of all kinds of experiences. On the other hand, the New World Order demands continuous training from workers, so virtual education takes advantage of the advantages of ubiquitous learning so that students learn to self-learn for life.

However, while many use technologies to enhance their training, they encounter the problem that they were not trained to manage the increasing amount of information available. Thus, although they strive to keep up with the constant changes, many are unable to find their way into and through an unfamiliar body of knowledge. Therefore, in virtual education, explicit guidelines are designed to enable them to chart an appropriate course of the inquiry, so that they avoid the difficulties and disappointments of not taking advantage of their full capabilities.

To innovate the teaching model, it is important for teachers to consider the potential use of technology as a tool for learning, but also to realize the limitations that are generated due to the so-called gap between the *digital poor* and the *digital rich*. Therefore, in virtual education, students are not isolated, because they enjoy personalized counseling and monitoring to ensure that they make proper use of technological tools.

Moreover, ubiquitous learning is more than an afterthought or an educational tool, since it is an innovation that conveys a vision of interconnected learning through all learning processes in which students coexist. It is a principle in which learning occurs not only in the classroom, but also in the home, the workplace, the library, the museum, nature, and in everyday interactions with others.

In the late 1930s, Harold Benjamin [68] claimed that students were educated based on a saber-tooth *curriculum*, i.e., to develop *competencies* that were useful in the Stone Age, but were not appropriate for that time. Today, even though so-called competencies are irrelevant for life in the New Age, the education system still trains on this principle and justifies it with the argument that competencies promote job training. Instead of structuring learning processes so that students develop skills, capacities, and abilities related to their knowledge and experience, the saber-toothed curriculum encourages essentially artificial activities, disconnected from reality, and useless for professionals in the New Age.

Forward Benjamin argued that schools should respond dynamically to the continual changes in the world and connect to the experiences of students in each era.

For the education system in the 21st century, learning must still be achieved through a process in which the student absorbs information and develops competencies as if he were a dry sponge. However, the reality is very different, because the conditions in the New World Order are different, and the new category of students live in a global, interconnected, and dynamic world, in which they continuously have learning experiences.

That is why they do not absorb information passively, but create active, personal, and meaningful knowledge from their experiences, and learn as they use technology to make sense of the world while building understanding from the evolution of information in the public sphere. Therefore, schools cannot underestimate the implications of globalization for education, because it is a fact that people live together in online communities where knowledge is changing, public, and widely accessible.

At first glance, it would seem that digital technology is what makes ubiquitous learning different from any of the written text and lecture-based approaches, yet that old model is also carried out on the new machines. Many features of ubiquitous learning have a proud place in the history of educational innovation, going back long before the New Age. While it cannot be overlooked that there is a link between ubiquitous learning and ubiquitous computing, i.e., the pervasive presence of computers in all aspects of life, it is this that lays the foundation for ubiquitous learning.

Therefore, the need for a paradigm shift in the education system is evident, because, in the same way, that digital technologies penetrate the social, productive, and scientific dimensions of humanity, they were almost immediately absorbed by the old methodological practices of teaching, content delivery and tests with *correct answers*.

The issue is not so simple, because that practice is nothing more than using technology to make students learn *old things*, the old way, i.e., it is just setting up today's ubiquitous computing devices for old-fashioned teaching, where the student works step by step through the content and then submits a test in which he gets a *mark that says* he won or lost. This is nothing more than recreating, with technology, the traditional transmissionist pedagogical model for the student to absorb the theories, formulas, facts, geniuses, interpretations, and socio-moral truths that the teacher considers right and good.

The real difference is enormous, because, although in the textbook the solar system remains immobile, the reality is that the planets move, and yet the traditional education system still considers that the student's relationship with knowledge and his learning model has not changed, and considers him as a static sponge that must *absorb* at all costs what the teacher knows.

According to Burbules [69], the tool of ubiquitous learning, beyond the marketing slogan of *anytime, anywhere, is a* principle that values knowledge from the multidimensional and transdisciplinary because:

1. *It is ubiquitous*. In much of the world, digital technologies have wide coverage and network access has become widespread, which means greater access to information. So, from a learning perspective, this spatial ubiquity allows students continuous access on a scale never seen before. In this scenario, the traditional distinction between formal and informal education also disappears, because society has recognized that physical location is no longer a constraint on where and how people learn. On the other hand, rote learning is changing, as students have less need to store in their brains everything they need to know for life because they simply turn to technology to remember it.

2. *It is portable*. The development of mobile devices makes it easier for people to have these tools at hand anywhere in the world. This portability creates new social practices; for example, young people do not use wristwatches, because they plan their activities in online electronic agendas that notify them in good time. These devices also allow students to encapsulate the contents of their learning processes and access them in their free time, i.e., technological ubiquity enables learning reinforced by the portability and practical integration into daily activities.

3. *It's interconnected*. Virtually all digital devices are interconnected, from automobiles to home devices. This feature offers students *extensible intelligence in the sense* that they improve their knowledge, memory, and processing capacity, thanks to powerful networks of interconnected devices. In addition, by being perpetually in contact with others, they can leverage what they know or can do to enhance their learning. People have access to intelligence in the network, so education defines what knowledge, skills, and abilities a student needs to store in memory, and which can be consulted in the collective intelligence.

4. *It is practical*. Digital technology blurs the divisions between ordinary activities that were once seen as separate because, for a variety of social and cultural reasons, they increasingly merge. These changes generate different expectations and ways of thinking about where, how, when, and why learning takes place, because the monopoly of school and so-called classes as the main, and even the only, sources of learning is re-evaluated. This has made it necessary to re-think the whole economy of attention, engagement, and motivation to learn; in addition to re-considering learning as a practical human activity, which is embedded in a wider network of social and institutional contexts, about the new set of genres and practices.

5. *It implies learning for life*. Exemplified differently, because the term has almost always referred to the principles of adult education, but now expands to mean the true availability of learning opportunities. That is why it has become almost routine to talk about the need for innovation in academic offerings and for students to develop new skills because the changing demands of the global knowledge economy require different professionals for the New Age. Therefore, *learning for life* means that learning is not relegated to age or time, to an institutional setting, or a set of externally oriented motivational structures, but that in the New World Order *being* means *learning*.

6. *It is global*. Because knowledge is immersed in transnational networks and flows of people, information, and ideas, learners *are* no longer in a specific place but are *located in* a set of relationships and contingencies that affect and are affected by increasingly global processes. Therefore, learning involves more than having pen pals in any country, experiencing exchanges,

or inquiring about the customs of exotic and distant places. What it is about is recognizing the fundamental interconnections between disparate people, places, and processes, and how they influence and constrain the seemingly local and individual context in which they inhabit.

In ubiquitous learning, the traditional boundaries of learning take multiple directions, so virtual education innovates and incorporates activities that involve new tools and resources to facilitate the achievement of learning outcomes. Traditional schools and teachers must stop considering themselves as the only source of learning because digital technology is making it ubiquitous, more practical, more up-to-date, and more affordable.

4.2 TECHNOLOGIES FOR VIRTUAL EDUCATION

Innovations in educational technology have taken many forms, which are used in virtual education to design learning processes with developments that enhance the achievement of learning outcomes in all phases and at all levels. At the same time, there has been a growing social demand for a revolution in the education system that has been felt around the world. Virtual education, where active learning, learning by doing, and collaborative work, together with the continuous practice of engaging students in one or more sensory modalities, is the basis for them to begin to experience true technology-mediated learning.

Taking advantage of the potential of technologies, in virtual teaching-learning environments students carry out research and development activities; they also have the opportunity to learn in an active learning environment and to play different roles with tools such as challenge-based and project-based learning. From challenge-based learning solved through projects, students are presented with authentic scientific objectives and are provided with the necessary advice, material, and tools. The student accepts the challenge of navigating, both in real and virtual reality, to achieve those goals and, in doing so with the guidance of teachers, learns to think and act as a problem solver.

Project development is carried out through collaborative work, with real-world assumptions, a focus on verification and validation of knowledge and learning, and a range of emerging technologies that allow students to take advantage of the knowledge they discover and the advances of the group. To achieve this goal, projects are designed and implemented to capitalize on the possibilities offered by technologies and virtual education. In addition, they are characterized by being role-based and goal-oriented, reality-based, promote hands-on and collaborative learning, are exploratory and interactive, are multidimensional and transdisciplinary, and are always advised by professors and specialists.

The interaction between students and professors in a virtual teaching-learning environment is mediated by technologies owned or acquired by the institution and facilitates activities such as discussion, brainstorming, knowledge exchange, concept clarification, and collaborative knowledge development while developing critical thinking. The medium provides greater access to ubiquitous learning opportunities by leveraging expanded education. In addition, the collaborative group work available electronically promotes the development of multiple perspectives and shared understandings among students, and between them and the teacher. Although in the context of virtual education, technologies are not assumed to be the main actor, their role is essential for the students, the teacher, and the institution to enjoy flexible communication. Geographically distant students connect socially with their peers, thus reducing the feeling of social isolation that is often associated with virtuality.

In the virtual environment, technology promotes a sense of equality, because each actor plays his or her role without restrictions; students are encouraged to participate because they do not feel intimidated and lose their shyness about expressing opinions or participating in analysis and discussion; and participations are more likely to be judged based on their value and merit, and not on the student's appearance or nervousness. The reason is that technology facilitates the construction of non-visual social environments that motivate and free participants from many of the social rules that intimidate them, so they participate through active and continuous dialogue to build knowledge in classrooms where they understand, comprehend, share and contribute to the development of a sense of community.

A well-designed virtual teaching-learning environment takes advantage of the changing forms of online communication and offers different perspectives for participants to communicate as receivers and as communicators. Learners access to content, browse for information, use web pages, make presentations and submit content. When communication is synchronous, they can see each other, listen to each other, talk, and even raise their hands, to recognize each other as a group. As in traditional education, in virtual education, there is a series of communication patterns among the participants in the teaching-learning process, but social stereotypes and the intimidations of public speaking are broken.

In contrast to traditional education, where technology is a kind of loose wheel to which the teacher may or may not resort in the learning processes, in virtual teaching-learning environments it is the core of the teacher's effort to design his or her teaching model. Teaching through didactics of simulation and scenario creation is facilitated in these environments, thus ensuring the achievement of learning outcomes. The potential of these didactics is that they involve the participants as active agents who determine their role in the context of the learning processes, and not as mere static spectators.

The technological developments of the 21st century marked the beginning of fundamental structural changes in society, and are an integral part of the significant improvement in the productivity of companies. In the same way, they impact education by supporting the teaching-learning processes, and, although in traditional education it seems that they are used as a simple accessory to modify the way the teacher communicates with students, in virtual education, they are a powerful aid for all participants in the learning process. Moreover, they are recognized and used to innovate the teaching model and didactics, linking teachers and students with content and resources, to help them improve teaching and personalize learning.

Discoveries in digital technologies and learning theories transformed teaching and learning in the New Age, and refined the social vision of what it means to learn. Individually and collectively these developments quickly became powerful tools for innovating the education system, and for engaging students in the learning process. Effectively harnessing the new teaching-learning environment involves the active and dedicated engagement of teachers and students, the design of rigorous and quality learning activities, and the efficient use of technologies such as those described below.

4.2.1 Virtual reality

After years of research and development into the educational applications of virtual reality, its effectiveness in achieving real learning outcomes has been demonstrated. With this technology, students learn sequences to perform any task working in three-dimensional spaces, such as

operating vehicles, arranging complex pieces of machinery, and orientation in unfamiliar landscapes. But, with the progress made in this area in the 21st century, it is also possible to emphasize declarative knowledge, immersive practice, and other activities that help students develop critical thinking and systems thinking.

Virtual education activities oriented to the achievement of learning outcomes, designed to acquire complex knowledge and to develop sophisticated skills, involve the teacher and students performing authentic tasks in realistic and relevant situations. The meaning of this learning does not exist independently but is constructed by each person as they discover, understand, and comprehend new knowledge, because it is based on what they know and believe, which they then shape according to age, previous experiences, context, and cultural strata. This leads the virtual teacher to re-know the student and design a teaching model that helps him/her to learn.

Virtual reality technology offers the possibility to enhance such learning because it has the potential to bring students into an educational immersion in which they work absorbed and engaged. This space draws them into a new world where they feel trapped and use narratives and symbolism to create credible and engaging situations to discover knowledge; they influence through individual actions and interact with peers and the teacher. In addition, this environment generates visual and audio stimuli with tactile interfaces, so that the student moves as in the real world.

On the one hand, the virtual presence in these environments enhances the motivation and learning of the participants, and on the other hand, it implies the voluntary suspension of the disbelief felt in the real world, so it is necessary to induce designs that use action, social, symbolic and narrative factors, on a par with sensory stimuli such as:

- *Immersion-action*: to facilitate an experience in which instinctive actions have been performed that result in novel and intriguing consequences of what the student wishes to learn. This is based on the fact that they are motivated by discovering their abilities to shape an environment and improve their attention.

- *Symbolic-narrative immersion*: to provide an experience in which students make semantic and narrative associations through the content, designed as a motivational component for learning. In this way, the intellectual, emotional, and normative archetypes involved create a complex overlay of associative mental models with learning.

- *Sensory immersion*: the egocentric panoramic view of the virtual world, generated by virtual reality, allows the student to place him/herself in that environment. This benefits those who need to learn declarative knowledge related to the subject they are studying.

- *Social immersion*: so that the student deepens his sense of immersion and is motivated to explore by feeling that he is not alone in that environment. This sensation should be a close replica of what they experience when participating in shared reasoning processes in the real world so that they take advantage of the environment to make decisions and discover knowledge through exchange with peers.

Leveraging virtual reality technology in this way is intrinsically useful in motivating students to achieve learning outcomes, because by mastering complex knowledge and sophisticated skills through collaborative work, they prepare themselves to do something they want to master and attempt to achieve, and then evaluate the results, in a process in which they discover the

knowledge they need to execute a more successful repetition of the experience. This intensive educational experience is based on situated learning, that is, it takes place in the same or a similar context in which it will be applied, so it fosters tacit skills through experience and modeling, in addition to generating integrated knowledge. That is why this type of knowledge requires authentic contexts, activities, evaluations, and the accompaniment and advice of specialists and teachers, as experienced by the student in virtual education.

Embedded cognition is related to this learning, because it is an instructional strategy to retrieve a concept from memory and reason about it, and virtual reality enhances it by allowing the student to create a simulation of it. For this he needs an embedded experience, to imagine it as a simulation of mental perception and to relate it in different contexts when learning about it. The resulting embedded learning is powerful, yet rarely acquired in traditional education, because creating the complex experience that facilitates it in the real world is a difficult task.

However, virtual reality is a technology with which these experiences are created with relative ease, as they are immersive and simulate the problems and contexts of real reality. In addition, the work is collaborative and takes place in communities in which students acquire knowledge and develop skills by interacting with their peers.

Another characteristic of virtual reality is that it makes learning different, and potentially more useful, than what is achieved in real reality; this is due to its ability to create interactions and activities in each educational experience that are not otherwise possible. For the virtual teaching-learning environment to be effective, virtual reality experiences must include contexts with strong narratives, authentic practices, and links to real reality outcomes, which foster the emergence of a wide range of complex knowledge and sophisticated skills.

The best experience offered by virtual reality is the *presence*, that is, the perceptual idea of *being* in the place the student *needs to be* to learn a certain subject. This condition of presence is perceived through the senses, for which the participant uses his whole body, following the implicit rules introduced in the immersion design. From these experiences, it is deduced that virtual reality contributes to achieving the learning outcomes because:

1. *It transforms the abstract into concrete*. A feature for learning that confers substantial advantages compared to traditional paper and pencil techniques because it illustrates concepts that lead to greater enjoyment, better conceptual understanding, and deep reflection on what it means to learn.

2. *It supports doing rather than observing*. This is important in virtually every learning process, especially in subjects where students are exposed to risks or there is the possibility of accidents occurring in the handling of objects in real life.

3. *It makes the unfeasible or impossible practical*. Teachers suffer all the time from the unfeasibility of presenting certain subjects to students because they may be dangerous or costly. But virtual reality allows the simulation of real-life scenarios in which all this is possible, for example, visiting faraway places, observing the inner workings of the human body, or entering a nuclear power plant, thus allowing students to generate knowledge while experimenting, without exposing themselves to risks.

4. *Manipulates reality*. Because it makes it easier to experience concepts of real reality, such as standing on the event horizon of a black hole; which is valuable for students to practice on them

as if they were a real laboratory possibility since virtual reality makes it possible for them to manipulate the parameters of real reality.

5. *Going beyond reality*. While virtual reality simulations make it possible to simulate and reproduce reality or manipulate parameters of reality, they also offer the possibility of going beyond what is possible in real reality and unexpected and radical ways. In this way, the teaching model is transformed to allow the student to learn in virtually any situation that can be simulated.

All this seems like science fiction come true to assist students in their learning process, and this is what has brought about the prosperity of technology and the sustained progress of society in this century. Virtual reality has unprecedented influence in many fields, including education, where it is leading to dramatic changes in the way people teach and learn. Virtual reality is seen as a mosaic of technologies that supports the creation of virtual teaching-learning environments and stimulates a high level of interactions between the teacher and the students, between them, and between all of them and society. It not only motivates learning but also awakens the desire for exploration and collaborative work because it is an interactive didactic that promotes the achievement of learning results that are not even stipulated.

Virtual reality is one of the technologies that best promotes the achievement of learning outcomes. But this is only possible if the design of the simulations takes into account the academic approaches and cognitive theories that are developed in parallel to the technology. Hence, one of the most important challenges to developing and using virtual reality in learning processes is that teachers and designers understand what they must involve from these theories, such as that the center of any teaching-learning process are students, that teachers are advisors and tutors who accompany them, re-cognize the experience and knowledge of students, and guide them to build new knowledge. Concepts such as situated learning, experiential learning, and collaborative learning should also be taken into account since they have similar characteristics to virtual reality.

A representative theory to take into account in the design and application of virtual reality in education is autonomous learning since the simulation must meet the learning objectives and the learning model of the students, while the teacher monitors the progress of the project and verifies and validates the learning results. This technology must provide the necessary resources for autonomous learning, giving students the possibility to select the most appropriate environment according to what they know, want, and need to achieve those results.

In addition, simulated environments must integrate different sensory modalities, such as sound, images, text, tactile cues, and even simultaneous combinations of multiple information. This creates a realistic virtual world in which students have an immersive learning experience. However, these multiple information and stimulation modalities should not be overused, because they may overload the learner's working memory and not allow him/her to achieve the established learning outcomes. That is why cognitive theories are taken into account in the design, construction, and presentation of the simulations, because otherwise the results, in terms of knowledge and learning, will be different from those planned.

4.2.2 Virtual worlds

This technology is a combination of other technologies, which makes it difficult to find a widely accepted definition, but, while it is important to define it precisely, it is also important to re-know its importance for educational practice. The issue is that if one does not know precisely what

virtual worlds are, teachers interested in taking advantage of their potential in learning processes could be mistaken when selecting these technologies because many are incorrectly labeled as virtual worlds.

The term *virtual world* requires a clear understanding of what is meant by the *world* and what is *virtual*. It is accepted that a *world* comprises: 1) the shared space inhabited and shaped by its inhabitants; 2) experiences and interpretations mediated through physical bodies and psychological responses; and 3) movements and interactions of those physical bodies with other bodies and objects, with whom it constructs a shared understanding of the world. *Virtual* is used to describe a simulated experience, i.e., a sensation of something almost real, perceived to exist, but lacking physical properties outside hyperspace. Therefore, it is reasonable to accept that the virtual world is a context in which we transfer our knowledge of objects and their use from real reality to representations in virtual reality, where they acquire alternative meanings according to the cultural stratum of those who inhabit them. It also includes the following features:

- *Persistence*. The virtual world exists regardless of whether it is inhabited or not, so there are processes in which it continues to progress, even if there are no connected users.
- *Affordable on a large scale*. The virtual world is contained in networks and without containments that limit its use, otherwise, it would only be virtual environments or spaces.
- *Multi-user*. Because the inhabitants of the virtual world are the ones who give it meaning and shape it according to their specific culture and needs, it must allow access to many users.
- *They use avatars*. As semi-autonomous agents that represent the users, capable of carrying out the activities that they indicate to them.

Virtual worlds offer ample possibilities for teaching and learning as well as multiple modes of participation, although inhabiting a virtual world implies consciously interacting with particular structures and limitations. Although the virtual world incorporates variability and different modes of access, particular styles, preferences, restrictions or structures define in part the educational experience of each user. In addition, the set of generic rules means that the inhabitants, in this case, the students, must first experiment with particular tasks, until they reach the level of experience that allows them to inhabit the virtual world.

This ambiguity should not be assumed as a problem in the use of virtual worlds in learning processes, because they have the potential to denaturalize aspects of avatars as teachers or students, which can be considered an interesting aspect of the virtual world for education. And while learning theories provide a reflective basis for teachers to design teaching models and structure didactics to develop learning processes, as well as tools to interpret the results, some of these perspectives are particularly relevant to virtual worlds.

These worlds offer environments centered on students' mental processes, emphasizing their role in constructing their knowledge through interactions with others and with the environment. Here they actively participate in the search for knowledge, with the guidance of teachers who encourage them to explore interactions in the social environment and to live real learning experiences. Likewise, in the process of inhabiting the virtual world, students communicate and interact socially with others, in a kind of community in which everyone learns from everyone else.

The role played by this learning community is an important factor in the analysis of education in virtual worlds, and reinforces the idea of improving or developing skills in students by associating with peers who have more knowledge of the subject. Analyzing it from this perspective, the

community is a group of peers who share a concern, a problem, a project, or a need to learn about a topic, and who, by interacting, develop knowledge and experience to respond to each need.

Another framework offered by the virtual world is that students experience experiential learning, that is, they learn through reflective action and critical reflection on each experience. This is because the learning processes mediated by virtual worlds achieve that students recurrently participate in concrete experiences, observation, reflection, formation of abstract concepts, and testing of implications in new situations. Therefore, each learning activity focuses on the experience of student avatars in a three-dimensional world, where they practice, test, and recreate situations, dilemmas, and challenges related to each topic of study. Subsequently, the knowledge and skills developed in these experiences are transferred to real-world situations and new scenarios.

This is achieved because virtual worlds are used to reproduce teaching activities that seem impossible in the real world. In addition, their social nature represents manifest progress in the tools that teachers use to communicate with students, such as discussion forums because they involve community work and establish unique exchange options. All of this has led many teachers to claim that teaching in virtual worlds overcomes the barriers that exist in the real world for the achievement of authentic learning outcomes. The reason is that this technology makes the student-avatar play the role of *doer-discoverer* of knowledge, facilitating the development of skills in the discipline being studied.

The virtual world also makes it easier for teachers to design a teaching model in which challenge-based learning and project-based learning are at the forefront. Because with this technology, students focus on solving multifaceted real-life problems, whether using role-playing, scenario-based activities, illustrative case studies, or participating in virtual communities of practice. In this way, both teacher and students participate in activities that place them in contexts where they achieve tangible learning, rather than abstract knowledge.

In addition, teachers design activities and tools similar to those that students will encounter in business contexts, because the goal is to train and empower them to perform complex tasks, much like those that occur in real life. These learning experiences allow students to develop experiential skills needed in the New World Order that help them innovate, create and engineer.

Virtual worlds are places where students achieve authentic learning through simulations, which allow them to manipulate different parameters in their structure and observe the consequences of each action since they are inside and are part of the simulation. There they interact with the environment in a very similar way as they would in real life while being active participants, not mere spectators of a static scene.

But, although this technology provides serious opportunities for learning, caution must be exercised, because there is still a risk that teachers may believe that students will achieve amazing learning outcomes because the virtual world is engaging and they may misunderstand its use as fun. Although a learning process using virtual worlds can be immersive and engaging, if the teacher does not have sufficient control over the simulation, it is possible to deviate from the original objective.

Virtual worlds provide a platform for activities that cannot be easily performed in real environments, so they are useful in those learning processes where practice could be considered difficult, dangerous, or even impossible in real reality. But, although there is evidence that they

are used for educational and research purposes, if the mainstream of virtual education is to adopt and use them more widely, it should be noted that, as a technology for this educational modality, it presents obstacles that must be overcome.

In the adoption of one or another technology for education, there are variations in approaches, determined by the institution, discipline, and teacher experience, that influence the selection of one or the other for teaching and learning. Since it is not easy to find training guides on how to teach in a virtual world, because most of them suggest ways of physical design, instructional design issues still need to be addressed. And while teaching and learning in virtual worlds is the next step in the evolution of instructional design, more research is needed on how to teach in these environments.

Virtual worlds are one of the most powerful tools available for virtual education, but it should be noted that the skills and knowledge associated with some disciplines are simply not adequate to develop in them. In any case, the reality is that a well-crafted simulation engages and challenges students directly and individually. Therefore, to get the most out of learning, it must work at a higher cognitive level than the recall required by traditional education. In the virtual world, the learner is immersed in the situation and develops knowledge and skills by facing the challenges and, when well designed, captures their attention for long periods. In addition, making the learning process relevant to the students arouses their emotional interest in the content and makes them more likely to learn.

4.2.3 Augmented reality

As virtual education progresses, new and creative didactics are being discovered for teachers to apply in their teaching model. From the chalkboard to the projector, to smart boards, to virtual reality and virtual worlds, the tools used in education have changed rapidly in this century. One such development is *augmented reality*, which provides new possibilities for teachers to innovate their teaching model and didactics in the learning process.

Augmented reality is a technology that adds digital features to the context of real reality, to *enhance* how the user experiences his or her experience in it. Using this technology, physical environments, such as the background or scenery, are added to a real-life scene, or other elements that interact with that environment, creating a *parallel* real reality in which objects or digital overlays appear that do not exist. This development uses devices such as helmets, gloves, tablets, and smartphones, and differs from virtual reality in that it does not immerse the user in a prefabricated reality, but creates a mixture of the actual physical environment and different digital constructions.

In virtual education, augmented reality gives new life to the virtual classroom, because it allows the student to develop creativity and interactivity, and acquires additional commitments in any learning process, thus reducing the time invested in understanding each subject. In addition, augmented reality offers other benefits:

- *It is affordable*. It does not require expensive equipment because it is used on tablets and smartphones.

- *It empowers expanded education and ubiquitous learning*. Because learning materials are accessed anytime, anywhere, and have the potential to increase the usefulness of paper-based text and physical models.

- *It encourages student participation and interest*. Because it is didactic in which the student learns interactively, and remains engaged in the learning process and the development of learning outcomes in a fun and effortless way.

- *Improves collaborative work*. It offers ample opportunities for teachers to innovate, diversify and revolutionize learning processes with interactive activities in which students participate and improve their teamwork skills.

- *Achieves better learning results*. Because students experience learning through visualization and total immersion in each learning process. For example, instead of reading the theory, they observe and actively participate in it.

- *Develop practical skills*. Accurate reproduction of conditions in a specific field helps students develop the practical skills they need to perform as professionals.

- *It contributes to job retraining*. In addition to the fact that the real environment enriched with augmented reality is safe, employees can be retrained in the handling or operation of new technologies, without risking their integrity or that of the company.

By introducing new information into the real world, augmented reality has the potential to provide contextual learning experiences and exploration and discovery of the universe. It is a process in which images are *enhanced* in real-time with synchronous virtual objects superimposed over them, so students can access more and better information than they get from the real world through the senses.

That is why virtual education leverages augmented reality for teachers to innovate teaching models, improve their efficiency and learning experience, and increase the level of achievement of learning outcomes. Because by combining graphics, vision, and multimedia the learner improves their real-world perception while providing them with an understandable and meaningful view of the subject matter and knowledge discovery.

Students improve retention and participation because the learning environment created is *fun*, engaging, and motivating for a media-conscious category of learners. Likewise, the environment is collaborative teamwork, and experiential, where students and teachers interact with the overlaid virtual information in a natural way. Everyone accesses a shared space filled with digital information, where knowledge transfer and achievement of learning outcomes are maximized, while demonstrations are observed to analyze results and variations in procedures.

In these digitized *classrooms,* participants in the learning process can see and hear supplementary digital information and manipulate it intuitively, allowing them to repeat the experience as many times as necessary, using tangible interfaces to examine and experience the material naturally. Despite its potential for learning achievement, augmented reality faces challenges such as:

1. *Teachers without the necessary education and training*. With the excuse that in their training they did not develop the necessary skills to do so, many teachers are afraid to experiment and take advantage of this type of technology. While faculties of education are responsible, many teachers do not have basic training related to education, because they graduated in other disciplines. In this century we need teachers who are open-minded, innovative, and capable of developing these skills on their own because there is no point in complaining when students surpass them in their ability to adapt to new teaching-learning environments.

2. *Lack of support tools*. Although the technology needed to implement augmented reality is scarce and it is assumed that students of this century have access to tablets and smartphones, the reality is that not all of them use them. This should be foreseen by the institutions and the State, directly responsible for the quality of education because by working together it is possible to narrow the gap and improve the cultural stratum of the digitally illiterate.

3. *Restricted compatibility*. Although this is an area of hard work, research is still needed to make augmented reality applications work well across all platforms and devices.

To advance in the solid construction of the body of knowledge on the advantages and potential of augmented reality in education, the research community has made great progress, but there is still much to be done. The call is to join efforts to advance at the same pace as technology does because we have lost many possibilities for innovation and improvement only because teachers and traditional institutions continue to use the rusty educational model of the nineteenth century.

Never before have we had access to technologies and discoveries in neurocognition as in this century, so it is time to take the plunge and start the revolution of the educational system, and technologies such as augmented reality provide us with the support to do it well.

4.2.4 Video games

Attention is a basic characteristic in the design and development of virtual teaching-learning environments, and their very existence depends on it. Unlike real reality, virtual reality is obliged to attract the attention of the learner as a condition for efficient operation and its very existence. For example, the fall of a virtual object in a digital environment does not resemble one falling in a real environment, because it is argued that it makes noise when it falls. Therefore, the perceived silence in the digital makes the object non-existent. The reason is that the sound, the environment, and the object only *come to life* until a user enters the virtual world with enough attention to see and hear what happens there.

In traditional education, students' attention is negotiated through grades, disciplinary actions, or praise, and is captured by compulsory school laws and the fear of failure, punishment, and disapproval. In these classrooms, the teacher is positioned as the center of attention, at the front of the group, and, as the central figure, is in charge of distributing information and knowledge for students to learn (or better, to memorize).

According to the advances and discoveries in the area of education, the trend in virtual education is toward progressive educational orientations, student-centered and situated learning, and learning for life. Standards and their legitimizing principles, and authoritarian texts and teachers lose control; at the same time, the structures of perception, thinking, and feeling, which keep students attentive to the teacher, tests, and texts in the traditional classroom, give way to theories and practices mediated by technology and supported by revolutionary tools.

In the virtual classroom, the student's right to be noticed is strictly respected, because in these environments their attention is neither earned nor deserved, on the contrary, the teacher is the one who must *earn* or *deserve it* because otherwise, the students will direct it elsewhere. This kind of destabilization of *authority* relations between teachers and students is a product of the familiarity with which new technologies are used. This gives students power in what they can see, think, and do because their attention adds value to education.

Students turn their attention to new technologies that undermine the old ties that bound them to a singular base and authority. For example, the telephone, a technology that once tied them to boxes and switches, has been freed and untethered from wires; moreover, the telephone is used not only for verbal communication but also for textual and video communication. This frees up the user's attention because while talking on the phone he can type on the computer, watch a movie or play a video game. Hence, in many environments, it is thought that the students of this century are multitaskers, although the reason is that technological developments are supported by individual and collective attention structures that promote multimodal and multitasking, with greater impact on people who live unbound to issues such as written text or compulsory school laws.

Technological developments and discoveries in neurocognition present an unprecedented challenge to the traditional monopoly of so-called *formal education* because, in the *attention economy,* people own and control most of their attention. In this scenario, education, which has always sustained its power in the business of capturing and maintaining attention, with centralized values and traditional tools, means, and purposes, has been progressively disrupted, destabilized, and displaced by new literacies and digital epistemologies.

A powerful result of this attention economy, and the empowerment of attention by students, has been the ability and success of popular culture to reach mass audiences with consumption patterns and practices. This *neuromarketing* has caused the entertainment industry to evolve rapidly and has massified and spread to virtually every aspect of people's lives, including education. Neurocognition found that when the seemingly disconnected spheres of education and video games are properly harmonized, they change the way teachers and students learn and develop knowledge.

Video games capture and hold the attention of players, which makes them a technology that education must analyze more closely because their impact on structures and forms of knowledge has destabilized text as the primary means of communication. Today, media compete for people's attention, and intricate structures are built just for the sake of it. For example, the popularity of a movie for young people is not only due to the book on which its script is based, but because of the large-scale enthusiasm generated by the derived toys, candies, and video games, to which followers almost automatically turn their attention.

In this century, video games are the technology that captures the most focused attention from people, because they first choose what to play and then trigger a two-way relationship in which the game encourages them to continue playing, through challenges and rewards that help them quickly learn how to play. In addition, the game and its environment, tasks, puzzles, quests, challenges, and rewards have a contextual meaning that captures their attention beyond the basic skills needed to progress to other levels. This makes video games a technology that uses the virtual classroom to capture and maintain the attention of students, so in virtual education, we learn from their structure to offer them learning processes that generate pleasure, fun, immersion, speed, progress, and efficiency of learning, in addition to the fact that they can develop knowledge and understand and comprehend it to achieve learning outcomes and expertise in the subject.

The fact that video games are a technology that gives players the ability to *learn* quickly, contrasts with what happens in traditional schools, where teachers are notoriously deficient in facilitating or enabling learning, especially when it is located outside the rules established by the system. The reality is that all people are intelligent and learn at their own pace, given their limitations of time, attention, experience, interest, motivation, etc., and this is what video games presuppose: that

anyone playing them can learn how to fight, drive, jump, etc. Therefore, it is rational to take into account their structure to innovate the teaching-learning process.

In virtual education, there is a concern, as there should be in traditional education, about why a young person invests money and time in learning to play a video game and does not want to do the same to learn mathematics. To answer this question, it is not necessary to carry out complicated research, only observation and logic are needed: video games are not only played but also talked about, read, exaggerated, fantasized, altered, and learned; in other words, it is an environment that attracts the attention of young people. They also manage to unite entire communities that participate in remotely located groups, so, if properly designed, they are a means to engage and retain remotely located students, and to support collaborative learning and the achievement of learning outcomes.

The virtual worlds of video games help to develop situated understanding, a basic element for achieving situated learning, which can be the basis for designing authentic and distributed learning environments. Therefore, the design of virtual teaching-learning environments is not simply a matter of offering the learner the material for each learning process, but also of taking advantage of emergent and situated structures and practices related to neurocognition. In such an educational context the critical piece of the puzzle of using video game technology is that they must be eye-catching in terms of concepts and content so that they catch the attention of students and make them want to play them to learn.

This technology changes the way people are taught, just as it has changed the way gamers learn. But you have to invest time and energy, and pay attention to detail, because video games are an educational technology that has meaning on a personal, experiential, social, and epistemological level for people. While this may sound scary to many teachers, what they should be asking themselves is whether they are interested in teaching more than just facts and skills in isolation and for a standardized test. In that sense, teachers need to understand that today's students live in virtual spaces where they compete, have structured relationships, learn, help others and, in many cases, govern. They are players accustomed to performing quality work because their experience makes them passionate and adds value to what they do; they have a sense of loyalty to their peers and are convinced that rewards must be earned based on the performance developed.

One way to leverage video games to motivate students to enter and remain in education is to re-know and understand their expectations and needs in the real world. As gamers, they have become accustomed to being heroes and we must take advantage of that instinct to inspire them to learn in other contexts and improve their performance, without forgetting that they also can concentrate and move quickly between diverse activities and, contrary to what many think, they are more sociable. Therefore, an educational video game must, at the very least: 1) provide structure, goal-directed activities, and standards that all students must follow, and that will be the ones they need to succeed in the New Age; 2) establish two-way relationships in which more experienced students collaborate with others; and 3) design challenges and rewards adjusted to the achievement of learning outcomes.

The success of this technology for learning also depends on its incorporation into the curriculum and the teaching model. From there, it is necessary to structure different ways to motivate students and provide them with environments to develop key skills, abilities, and capacities with which they can develop critical and systemic thinking, as well as strategic planning.

In this way, a virtual classroom is organized in which the video game supports and encourages students and teachers to share and work in teams. The student wants to win, master the content and make rational decisions about learning; he wants the adventure while learning cooperatively, which makes it easier for the teacher to structure, plan and manage each learning process.

Well-designed video games immerse students in virtual worlds where they are bound to develop problem-solving skills to respond to challenge and achieve defined goals. In addition, they develop other skills and become aware of the consequences of acquiring knowledge, or not having knowledge, as their learning is reflected in total scores. In this way the teacher collects student decisions and verifies and validates their progress, critical thinking used, and other indicators for the achievement of learning outcomes. The power of a well-designed video game is to get students to stretch their minds and experience a real immersion in the virtual world because they assume a predisposed identity to discover knowledge and learn.

It cannot be forgotten that motivation is an internal state that awakens, directs, and sustains students' behavior, in addition to making them strive to achieve particular goals. That is why curricula should be structured to offer them learning processes with meaningful and valuable activities that motivate them to foster learning. Extrinsic motivational factors, such as the potential for deeper learning and higher tangible rewards, combined with the expected intrinsic motivation, are ultimately what demonstrates the usefulness of video games.

This is because achieving the final goal of the video game is challenging, and students need to draw on prior learning, obtained through the video game itself or in collaborative work with other players. In this way, they discover and develop knowledge as they progress through the stages of the game and develop new skills to execute the activities presented to them by the virtual world. Achieving ultimate success, i.e. *winning*, requires students to demonstrate a high level of learning and the development of progressive skills, therefore, a well-designed educational video game enables them to:

1. *Obtain rewards based on achievements*. For this, you need to demonstrate specific knowledge and skills, and achievements can be: achieving a specific score, demonstrating a certain skill, or solving a specific puzzle, in the process of which you must demonstrate and use the acquired knowledge.

2. *Self-assessment and repetition*. The video game allows the student to measure his performance through self-evaluation of the knowledge and skills developed. In addition, since to progress through the levels of the game he has to demonstrate certain skills, he should have the possibility of repeating the level that generates difficulties until he develops them. Immediate self-assessment and repetition is a learning strategy that is widely welcomed by students because it defines the time they need to spend on a particular topic while keeping their minds oriented on the challenge of achieving the goal.

3. *Use prior knowledge*. The video game demonstrates to the student that what he learns and the skills he develops in one level he needs for the next. In this way, he accumulates knowledge and skills as he advances through the levels, and when he reaches the final goal he has developed the knowledge to achieve the established learning outcomes.

4. *Control the time they spend learning*. In such a way that they can schedule the time, moment, energy, and place they need to invest to play. This is because people focus on different periods, and what may take minutes for one learner may take hours for another. Therefore, the video

game must offer logical start/stop points that the student takes advantage of to take breaks and recharge energy to continue learning.

In the New Age, a dedicated and observant teacher is obliged to re-understand aspects of learning and how students learn, but this is almost always not possible, as the necessary knowledge is overshadowed by standardized tests and indicators that lead to students' neglect in the traditional classroom. When learning processes are challenging, motivating, and engaging, students thrive in learning and beyond. A difficult and meaningless learning process causes them frustration, but one that is too easy bores them, and the same can be said for video games. If it's too easy it doesn't appeal to them and isn't fun, but if it's challenging it draws them to the point of not wanting to put it down, which is no different than a good movie or an engaging book.

The video game must be balanced and with a level of complication that the student must resort to multiple cognitive juggling, choose what and when to prioritize, and decide what to defer. These reasonings affect their decisions on conceptual and psychomotor levels of real reality, such as which buttons to press, how to interact with other people, or which areas of the work environment they can choose to explore and expand their knowledge.

The success of video games in innovating education does not depend only on technology or innovations in the teaching model but requires a broad institutional re-organization involving the curriculum in general. If this is not done as it should be done, the results will resemble those achieved by companies at the beginning of the century, when they tried to involve new technologies in their production processes in the hope that it would be enough to improve quality and sales. But they forgot that they had to re-train employees, re-design the systems architecture and business model, and re-think distribution, so in the end, what they achieved was to intensify their problems.

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5. INSIGHTS RELATED TO VIRTUAL EDUCATION

One of the decisions that families and individuals, in general, should think about is which education to choose. First of all, it must be an education that is both appropriate and attractive for everyone, because people are different and have different educational needs and preferences, so the education system must allow them access to a differentiated education. In this sense, one of the most outstanding innovations of this century is virtual education, which is the best alternative to the outdated educational model and is emerging as the best solution to the endless problems of the education system.

Virtual education is structured in a personalized way based on the strengths and needs of the students, who are advised on what educational aspects work best for them. This personalization awakens students' willingness to learn because it is flexible and achieves learning outcomes that have real-world utility. Moreover, since the success of education depends on evolution and adaptation, virtual education reflects both processes, because it is an evolutionary stage of traditional education, and it adapts to the New World Order and to a society that coexists with technology.

Virtual education offers several possibilities for situated learning because it sits at the pinnacle of the evolution of educational types, takes advantage of globally available techniques and tools, far surpasses the limitations of traditional education, and builds on the possibilities of previous types: Early educational institutions were built around books and manuscripts; distance education was built using text and asynchronous forms of communication; the traditional educational system was built around physical buildings with meeting and conference spaces; while virtual education is supported by a network with unlimited and ubiquitous access to quantities of information, uses synchronous and asynchronous communication, and validates the prior knowledge of the actors.

This type of education offers a vast potential of tools and technologies in which almost all previously used modes and media are included, including the overvalued face-to-face interaction. Depending on didactics, content, learning achievements, convenience, technology, and time availability, various forms of interaction are substituted for each other in the virtual classroom.

In this type of education, the quality of learning results is not diminished; on the contrary, it is higher, because students develop high levels of deep and meaningful learning. The reason is that in the virtual classroom not one, but all forms of interaction are experienced: student-teacher, student-student, student-content, and student-teacher-society, surpassing what happens in a traditional classroom, where hardly one of them is achieved.

Virtual education requires the teacher to choose, adapt and refine, through feedback, verification, and validation of learning outcomes through reflective activities that maximize the possibilities of technology and neurocognitive discoveries.

In addition, it designs learning, knowledge, assessment, and student-centered educational experiences with high levels of learning for all. Like any type of education, virtual education integrates harmoniously and structurally the State, administrations, teachers, students, families, society, and the productive sector, because survival in the New Age is a task that we must all achieve. In addition, a series of relative appreciations, such as those described below, must be respected.

5.1 ETHICS

Ethics and morality are terms that are broadly defined as relating to the right and wrong conduct of people, although both provide very different standards for defining what is right and what is wrong. Ethics is a personal and individual quality, while morality is a quality that is defined in a group, i.e., individuals have ethics and societies have morals. In any case, in a proper frame of reference, it is stated that violating any of these meanings is wrong, therefore, it is a relative appreciation that must be analyzed in virtual education.

The point is that when ethics are discussed in any frame of reference it is assumed that they are motivated by values such as respect, truth, sincerity, fairness, justice, equity, and responsibility, and yet valid rules are needed in the community to regulate actions and enhance mutual understanding between people of different cultures, customs, and nationalities. This is important and necessary in virtual education, more so than in other frameworks, because it brings together people of different races, religions, cultures, and nationalities, who come together to learn and share experiences, skills, and knowledge while working with each other. Therefore, rules must be established about how to deal with differences and similarities to ensure that everyone's needs are met.

Almost always the lack of satisfactory intercultural communication originates in well-intentioned statements because each person in the community tends to behave, speak and share according to his or her own culture, which many times may not be appropriate for another. To avoid this in virtual education it must be clear, and all participants must recognize, that cultural, religious, and language identity are an integral part of everyone in the classroom. But this does not delegitimize the need for everyone to look for ways to create a harmonious teaching-learning environment in which these differences can be avoided.

This is an integral part of what is learned by working collaboratively with others, and so it must be assumed to work together and help each other to learn. What is not allowed is that dominant intentions arise, because this breaks the harmony of the group and leads some students to feel excluded.

In virtual education, ethical issues related to respect for the individual are paramount to maintaining a harmonious teaching-learning environment and cooperative work, so it is advisable to agree on and socialize a code of conduct for participants. This practice is common in many communities in the real world and is a good way to avoid inconveniences or misunderstandings in the classroom. In the case of virtual teaching-learning environments, it is necessary to think of a code of ethics that, at least, contains definitions and regulations for the:

1. *Language*. The first thing to define is the language in which each learning process will be carried out because it is one of the most important elements of people's cultural identity. Learning processes can be taken by students from any part of the world, having collaborators and specialists who speak several languages and come from different cultures. This requires defining a common language for all participants since the objective is to work collaboratively and in teams. The key is to find an adjusted level of communication with which the whole group feels comfortable because using jargon or colloquialisms can generate misunderstandings and confusion for non-native participants. The recommendation is to use simple, clear, and brief language, and to make the native speakers aware of the need to help others in the use of the language. This can also happen if all the students are native speakers of the same language,

because there are differences in language use between countries, even between regions of each country.

2. *Behavior*. In the groups that take the learning processes of virtual education, there is an intercultural exchange without limits, which is used for the participants to enrich their knowledge beyond the learning results. In this multicultural context, it is necessary to establish rules of behavior in the interaction, including how to identify oneself, how to behave, the style of communication, and the frequency of participation. This helps to de-escalate many of the students who do not participate for fear of offending others. One component of behavior that is difficult to manage is humor because it is both personal and culture-specific. Therefore, socializing behavioral etiquette in the virtual classroom is an activity at the beginning of the learning process.

3. *Authorship*. One of the most important ethical issues in academic work is to give everyone the recognition they deserve and, since in virtual education the knowledge developed and the achievement of learning outcomes is verified and validated through challenge-based and project-based learning, it is convenient to specify from the beginning the ethics of authorship recognition. Students should be aware that, when using theories, processes, or definitions taken from any source or material, they must inform the source and the respective author of each. In addition, whenever they copy content from others, even if it is to rephrase or summarize it, they must properly cite the author.

A code of ethics serves to make participants understand that on the web they must also respect certain conditions of life, because, while virtual worlds may be broader frameworks of reality and experience, they are a component of existence in which ethical reflections are important. Therefore, if we understand the virtual as a radically different space from real reality, this does not mean that ordinary understandings, practices, and experiences have to be equally different. The virtual world also requires ongoing ethical reflection, albeit novel, with ethical frameworks that may be unique, because it is a continuous rather than a discontinuous space.

As many science fiction authors and scientists warn, the boundaries between virtual and real worlds are blurring as technology develops, so at first glance, the resulting ethical issues may seem genuinely novel. But as seen in the history of ethics in general, specifically in the history of computer ethics, society finds ways to define, establish, and apply frameworks to resolve ethical challenges that arise in virtual reality. This does not mean that these frameworks cover what exists and what is to come in the subject of ethics because new and significant challenges always arise that may not be taken into account.

In any case, what matters is that people living in any of these worlds have to understand that their humanity is permanent, regardless of whether their behavior is reflected in person or an avatar. The real reality we live in is increasingly influenced as our lives are invaded by virtuality, but taking advantage of this society cannot be at the expense of our humanity. A virtual teaching-learning environment is nothing more than an extension of a lived reality from education, so participants are people who have to recognize the humanity of others and behave ethically, just as they do in real reality.

5.2 RIGHTS AND FREEDOMS

Thanks to technological developments, new forms of mass communication have emerged that pose obstacles and regulatory challenges to the rights and freedoms related to coexistence. This

is a sensitive and problematic issue that generally conflicts with other constitutional rights, such as freedom of expression, privacy, and use of data and information because it is not easy to establish responsibilities.

Hence the importance, from a regulatory point of view, of establishing criteria in virtual education to ensure that the virtual teaching-learning environment maintains a particular level of neutrality in this regard. In this sense, the need is identified to establish a system that makes it possible to identify the responsibility of those who participate, whether it is adapted to the regulations of the country of origin, or whether it mainly includes concepts of international law.

The fact is that so far no technology has been developed that surpasses the ability of virtual worlds to mimic real reality and allow human interaction. It is therefore natural to think that the rights and responsibilities of real reality must also be respected in virtual reality. However, no treaty sets out a general international standard for living in a virtual world, and those published are proposals and adaptations of each country. In any case, virtual education must have clarity in aspects such as intellectual property and its protection; protecting speech, image, and avatars; freedom or not to record video or audio; guaranteeing the right to privacy; data protection; and the right to free expression, among others.

We assume that participation in a virtual teaching-learning environment should be a two-way transaction between the institution that provides it and the people who access it. In this case, students and teachers accept the terms and policies of the virtual environment, in return, they acquire the right to use it for educational activities, but within the established legal limits.

Another issue is that this environment is a private property in which technologies, software, images, texts, and materials converge with independent terms and policies of use, so users are also obliged to respect them. In other words, the terms and conditions for using a virtual environment are established in two contracts: 1) the one signed with the institution, and 2) the end-user license agreement established by the suppliers of the technologies and services used.

This means that the issue of rights and freedoms is not overlooked in virtual education, because the virtual classroom is made up of fragments of code that materialize in the elements that make up the virtual world. These elements placed by the software belong to the owner of the virtual environment, but what about the elements that students or teachers create, and that the environment uses as embedded components? In this case, several scenarios must be clearly defined, both for the institution that owns the virtual environment and for the users.

It may be that a part of the virtual environment is public, i.e. it has no restrictions to, for example, use images and other visual elements in the dissemination of the virtual world. But if those elements are taken to achieve remuneration, the institution has every right to claim. However, the institution can declare that any content published in the virtual environment automatically grants it the right to use it in any way it requires. Therefore, users should be assured that the intellectual property of their work will not be affected, only the use and, therefore, they will not be able to prevent the institution from using them to promote the virtual environment.

This is considered a right of use and does not affect copyright, since virtual elements are protected as if they were literary works. The institution designs clear and informed procedures to use the elements that students or teachers create and upload to the virtual world, so by doing so, they unconditionally accept the such provision. What the institution cannot do is take over the copyright, which is non-negotiable, and authors can register their creations without violating any

provision of the institution, or decide not to upload them to the virtual world and limit their use and disposition. But teachers should be aware that many institutions stipulate in their employment contracts that all teaching production belongs to them, although this may not violate their copyrights either.

The issue of avatars is a matter that should be looked at carefully in virtual teaching-learning environments, because they are a graphic representation of the user that, although selected from those designed by the virtual world software, can also be designed and created by the user himself. If they are selected from those offered, they belong to the institution, but if they are created they belong to their author. In addition, if it is distinctive or almost entirely reflects the appearance of its creator, it may have not only copyright but also other types of protection. The reason is that this resemblance can generate inconveniences for the creator when another user uses it for issues unrelated to the virtual environment.

Since the institution acquires the right of use when the student uploads the avatar to the virtual world, it is feasible that it can use it in advertising and promotional materials without the need to request permission from the creator. This does not infringe copyright, but if the institution uses it to obtain some kind of benefit, the author has the right to prohibit it or claim compensation for damages.

In virtual teaching-learning environments students and teachers participate according to the provisions of the platform and according to their personal preferences. They may use a microphone to speak directly in the virtual world, which makes their speech audible to all participants, or choose to type, which makes their participation appear as text on the virtual world screen. But, as is often the case in traditional education, a learner may decide to record the sound or image of the learning process, so do they require permission to do so?

The best answer to this question is: *it depends*. In most countries lectures, speech, and other educational materials are copyrighted, so to record any or all of them is to create an unauthorized copy. But, if the recording is made for personal use only, then it is allowed since the one who records will be the only one who has access to it. The opposite is the case if the recording is distributed, since in this way copyright is violated, and both the institution and the teacher, and even any student who has participated, could be sued.

Student and teacher information related to the academic process is also protected from public dissemination and use. This information may be represented in the form of personal data, grades, or academic records in logs or portfolios. So, can the institution use this information as part of, for example, an advertising campaign? There is no denying that institutions have a responsibility to store this information and maintain educational records of students and faculty, but they cannot disclose it without written authorization from its owner. Moreover, while they can do so as reports and management indicators, they must ensure that the identification of the owner is not compromised.

These are just some general considerations about rights and freedoms in virtual teaching-learning environments, but there are many others for which there is still no legislation. Therefore, virtual institutions are obliged to implement a self-governance model in which they define policies and procedures to anticipate any conflicts in the real world, as well as procedures for resolving them. In addition, they must put in place disclosure procedures to ensure that they are known and understood by all actors in the system.

5.3 THE RESEARCH

The skills needed for research in a virtual teaching-learning environment do not change from those required in traditional education, but both the student and the teacher need to develop and hone their ability to search the web. They may have access to libraries and bookstores, but their choice to educate and teach virtually is enough to make them unwilling to do so as in traditional education. Technological developments facilitate the digitization of information regardless of format and transformation, but also offer a variety of options for retrieval. Thus, most of what is found in printed books and journals can be found on the web, without the restrictions of schedules and locations.

Because the information on the web is not indexed in a standard way, it can be difficult to find what you need; moreover, the quality and validity of that information are questionable on more than 90% of the sites. So without a structured search strategy, you could be *shipwrecked* in the ocean of information, and it would be the same as wandering through the shelves of a real library, trying to find a book. That is why the student and the virtual teacher need to develop and refine their web search skills, in addition to: 1) having a clear understanding of how to prepare the search, and 2) knowing how to use the various search tools.

Keep in mind that researching on the web is different from researching in, for example, a traditional library, and this can cause problems for many people; moreover, the web is a powerful resource for researchers, but it should be used carefully and critically. Many digital resources, like print, are almost always carefully evaluated before they are published. This peer review makes the difference between one source and another, as the content is expected to be of good quality. In a real library, materials are cataloged and collated judiciously and systematically, using standardized procedures around the world, which is the basis for organizing digital or print materials and making them searchable through a catalog.

But the Internet does not always have this method in place, because anyone can upload resources and materials to a site without a review or selection process, and there is rarely the possibility of identifying sources and creating cross-references. This means that much of this material is not of good quality, and the researcher needs greater certainty about the suitability of the author and the basis on which they use it as a source. This could be assumed as the most important thing about the Internet, or also as its weakness since for many it is freedom, but for others it is chaos, so when researching virtually, it is necessary to pay attention to the sources of consultation.

However, there are several solid academic resources available on the web, such as journals, publishers, research centers, universities, and academic or scientific organizations, and it is best to follow certain guidelines when consulting them:

1. *Do not rely blindly on their content*. Students are inclined to consult only on the web, but sometimes, depending on the topic, the content of these resources must be verified on several related sites. Taking as true what is presented on the first site consulted is a mistake because there is no assurance that the content is reliable and safe to include as a source in research.

2. *Limit the research topic*. Any simple web search offers an enormous amount of sites with related information that can overwhelm the researcher. Therefore, it is recommended to narrow down the topic before starting the search and it is wise to structure the search to target and limit the possible results.

3. *Recognize search engines*. The web ranges from peer-reviewed subject directories to search engines that direct the search using sophisticated algorithms. Each one has its algorithm and may offer common sources and others that only that engine consults. That is why it is convenient to take the time to recognize them and learn what each search engine does, to decide to use one or the other. But each algorithm is different, so there is no concordance in the results, therefore, it is best to use two or three engines for the search.

4. *Record the sites consulted*. Since the volume of sites on the web is overwhelming, good research practice is to keep a record of the sites visited, both those considered as true sources and those that do not contribute to the research. This provides selection information and helps to avoid wandering around useless sites.

5. *Verify the links*. Before including links as sources you should verify that they are well-written and still working because it is easy to make mistakes with web addresses.

Since the results of the research must be structured and accurate to a high degree, it is important to be sure to use reliable resources. Below are some recommendations to verify the quality of a website:

1. *Authority*
   - The author is known
   - His academic production can be accessed at
   - There is extended information about it
   - Has contact information
   - It is recognized in the community
   - It has more related production

2. *Affiliation*
   - Site sponsor is known
   - The author is affiliated with any institution or organization.
   - The content reflects the views of the organization or the author.

3. *Target audience*
   - The target audience of the content is identified
   - The site delivers on that front

4. *Update*
   - The information on the site is updated
   - Provides information on the date of publication
   - The published links are updated and working

5. *Reliability*
   - The material is reliable and accurate
   - The information is real or just opinions
   - The information can be verified in other sources
   - The sources used are clear and verifiable.
   - Sources are valid
   - The content is substantial and concrete
   - Argumentation is based on solid and logical evidence.

- The author's point of view is unbiased and objective.
- The language used does not reflect emotions or prejudices.
- The content is orthographically and grammatically correct.
- Offers complementary or backup sources

These recommendations are of great value for the researcher to optimize his work, otherwise, he will waste time trying to find something that may have been presented to him in several of the sites he enters. Web resources abound and can be of very good quality, but some sites contain only *junk* for research.

One way to find reliable content for research is to master certain specific skills because searching for a fable is not the same as searching for material to develop a structured research paper. The researcher must avoid the frustration experienced when searching the web due to common misunderstandings. To help you, here are some aspects that could ruin your work:

1. *Create high expectations*. No one can deny that a network is a powerful tool for researchers, but it has its limitations. Serious research is not done only in front of a computer, and although in this document we are talking about virtual education, we are still far from having all the information, in any of its representations, digitized. It is one thing for that information to be updated and quite another for it to be complete. There are many documents, articles, proprietary information, books, tacit knowledge, and papers that are still hidden but can be invaluable sources for research. In other words, believing that everything and anything can be found on the web is unrealistic; sometimes you have to look for it in non-digital sources.

2. *Synonyms and antonyms*. A wide diversity of cultures, languages, and customs converge on the web, adding difficulties to searches. Often, even if two cultures have the same language, the meanings of a specific term may be different, which can frustrate the careless researcher. In addition, terms may differ in the way they are spelled, so it is necessary to determine which terms are of interest and to structure a search sequence in which synonyms and antonyms can be omitted or included. Unless the search engine is provided with precise terms, the results are numerous, because it includes sites that contain all possible meanings of what is being searched for.

3. *Upper and lower case*. It is important to define how the research term(s) will be searched because some engines differentiate between uppercase and lowercase, and between words with initial capital letters. Therefore, if the search is performed with lowercase words, the result will be overwhelming, when what is needed are results for a word that has initial capital letters.

4. *Advanced search*. This should not confuse the researcher and although many rely on the simple search for fear that the advanced search is *too advanced*, the reality is that this search is the best way to find information.

5. *Response speed*. Many researchers consider that the speed of response of a search engine is the characteristic that differentiates it from others, but that speed depends more on the connection. The most important feature that distinguishes one engine from another is what is being searched for because it may or may not be contained in its database and therefore has to go through more sites to find it.

On the other hand, researchers struggle with the fact that the network is growing daily, making it increasingly difficult to find the necessary information, a reality that reinforces the importance of

structuring an adequate search technique. Since researchers do not want to waste time with voluminous and difficult-to-analyze results, they must develop skills to take advantage of the network as a source of information. Likewise, they should not limit themselves to one or two pages of results, because it may not offer them much; in these cases, it is better to use techniques to manipulate the search engines to obtain fewer results, but closer to what is expected.

Another issue to be taken into account is that search engines insert on the first page a series of sites *disguised* as advertisements, which deceive the researcher because it considers that the location determines the reciprocity with the search. This is nothing more than advertising for which the owner of the engine charges, and every day this practice is becoming more widespread in all Internet services. Therefore, structuring the search, manipulating the search engines, and being patient is the best way to research the web.

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6. DESIGN OF VIRTUAL TEACHING-LEARNING ENVIRONMENTS

It is common to use only the expression *virtual learning environments*, without the *teaching* component, due to its advantages in this century and without taking into account a series of concepts and principles necessary in virtual education. Many institutions believe that using new technologies is sufficient for students to participate and achieve learning outcomes. In addition, they adopt slogans such that they are accessible from anywhere and at any time.

However, the success of virtual teaching-learning environments lies largely in their design, because one of the situational factors associated with learning in virtual education is centered on the motivational conditions of students. Therefore, the design, development, and implementation as a continuous improvement of the environment must be appealing and motivating. As an Information System, it must ensure compatibility between design features and user requirements. Since in this environment, the learner is the center of learning, the design approach must also be user-centered, satisfy the user's needs, provide net benefits of use and attract the user's attention to interact, discover knowledge and acquire learning.

In any learning process, research results should be used to link the student with his or her learning possibilities. That is why in virtual education it is important to re-know and use the properties of the design of the environment related to motivation and teaching effectiveness, in addition to identifying and integrating the findings of neurocognition. The student's motivational response in the virtual environment is positive when he feels challenged and evidence effectiveness for his learning. On the other hand, as a user of the Information System, he expects the virtual environment to awaken his curiosity to get into the complexity of it while practicing what he learns and convincing himself that learning is useful in real life.

With the development of Information Technologies, education has discovered new teaching methods that use the Internet and multimedia to support the teaching model. However, most of these methods are no more than an extension of the teacher-centered teaching domain, because they emphasize the aspect of communication with students and forget that learning processes require interactive teaching-learning activities. In addition, teachers do not develop the necessary skills to use these tools, being surpassed by students in this aspect. The result is that institutions rush to offer learning processes mediated by technologies, which they call *virtual learning environments,* and in which the teaching model is not innovated.

If the goal is for this virtual learning environment to be a more flexible educational modality than the traditional environment, it must also include a new teaching model. Since the network is seen as a huge repository in which information and knowledge are logically connected, it is natural that people would want to use it to develop learning. However, to take advantage of this technological resource, a new conceptual framework needs to be created in which the curriculum, teaching model, didactics, and learning model are integrated into the construction of a true virtual teaching-learning environment. This means that the actors need to develop new skills, abilities, and technological capabilities, in addition to taking advantage of neurocognitive discoveries, to challenge and motivate students to remain in the system until they develop the learning outcomes that qualify them as professionals.

This is not achieved with static virtual learning environments in which the aim is to transfer the traditional classroom processes to a digital format. This process is simple and teachers limit themselves to uploading documents, presentations, and *assignments* for the student to read asynchronously and prepare for *tests*. The meaning of a virtual environment is more than adopting technologies and giving them names such as computer-assisted instruction, intelligent tutoring system, interactive learning environment, web-based learning, or computer-assisted collaborative learning, thereby expecting students to develop skills and achieve learning outcomes.

All these sites do is deliver a lot of content and delegate responsibilities from the teacher to the students. A good virtual teaching-learning environment is dynamic, combines synchronous and asynchronous communication, and integrates artificial intelligence, new technologies, and artificial neural networks with developments and discoveries in education and neurocognition, to develop or improve human learning. The idea is to design an environment in which information is discovered, shared, understand, and comprehend to the point of generating knowledge, which is then practiced and developed to achieve learning for life.

Hence the importance of adequately eliciting and evaluating the necessary features for the design of virtual teaching-learning environments that are relevant to the stakeholders and that can be developed, implemented, and improved. To achieve this, a holistic approach to Software Engineering needs to be applied, because the design features cannot be restricted to those used in the previously mentioned systems. However, as an Information System, designing a virtual environment involves integrating and enriching a broad set of relevant aspects of Software Engineering and education, because without an accurate understanding developers could draw wrong conclusions based on previous misconceptions, as they would rely on results that seem adequate, but are irrelevant to education in the New Age.

A premise to keep in mind in the design of these environments is that both the technology that supports them and the interface they deploy make a significant difference in the achievement of learning outcomes. Even if a nice site is designed, with eye-catching learning processes and dynamic interactive work, if access is slow, navigation is unstructured, the use of panels is confusing or hands-on activities are difficult, the learner is not motivated or challenged and learning is ineffective. Therefore, it is also important to identify appropriate hardware and software to develop a structured, consistent and shareable site.

Integrating these principles and theories encourages student responsiveness, a basic characteristic of any virtual environment. The objective is to get students involved and actively participate, to generate responses among themselves, and to initiate a chain of interactive action-reaction. This situation, in which relationships are mediated by the computer, is similar to what happens in a conversation or social dialogue. In any case, there is some form of immediate response to the student's action, but to generate effective learning, students must be given space to discern or make connections between their actions and the response activity.

This recognition of the social character of the students positively influences their level of interactivity within the virtual environment, which is why when designing it, strategies must be incorporated to exploit this potential and incorporate social experiences that motivate students to *be* and *participate.* It should also be remembered that they are reflected in the avatars and that this participation should be treated as social interaction. This approach helps to understand the student's motivation to participate in a virtual environment.

The design of a virtual teaching-learning environment should be guided by motivational and academic considerations, and one feature that motivates students to stay is that they find a wide range of ways to navigate (use) the environment. In this way, they feel they are in control and can make active decisions of their own, without needing the teacher to tell them what to do. But the environment cannot be so open, because there is a risk that students feel overwhelmed and decide to experiment with all the options to calm uncertainty, something associated with a lack of confidence in their knowledge and skills. Since in virtual education, the first thing is to get to know the students before they live their first experience in the virtual environment, the design of the virtual environment must match their expectations and needs with the location in the environment, all mediated with challenge-based and project-based learning.

6.1 FACTORS INVOLVED IN THE DESIGN

The success of virtual teaching-learning environments involves different factors that must be considered in their design, as well as the complex ways in which these factors interact in the virtual learning community. Humans react in different ways to situations they do not understand or comprehend, and if the virtual environment has design flaws that make it different from those used by students to socialize, they will not see it as a stable system that mediates how they select, construct and process information and generate social behavior. It is necessary to incorporate options that provide lasting patterns of expectations, goals, and plans because they are more likely to value learning.

It is important to assess the responsiveness of students and to design attractive virtual environments, with easy technical and operational characteristics, because the objective is not to hinder learning, but to facilitate it. In addition, students have their own personal, community, and affective motivations that require specific situations to enhance them, and what could be more specific for this than a motivating virtual teaching-learning environment? This is also influenced by the facility that students find to generate, in addition to those established in the learning process, their learning results, so the virtual environment must be a catalyst for their mental models and their predisposition to learn.

The key to integrating the intervening factors in the design of virtual teaching-learning environments is to facilitate the connection between the learning process and the student's perception. This requires, as mentioned in this book, re-acquainting the learner with the knowledge and experience he/she possesses, and his/her evaluations of a virtual learning situation. In this way, the active state of mind links the learner to the context, as well as identifies critical forms of interdependence with the learning process. The quality of this experience is not only a result of the learner's personality characteristics but also of how he/she perceives and interprets his/her motivation. Some of the factors involved in the design of a virtual teaching-learning environment are described below.

6.1.1 Cognitive overload

As a teaching-learning environment that develops at the student's pace, the virtual environment imposes a greater mental workload than that experienced in traditional environments. The reason is that everyone develops the learning process at their own pace and can review a topic or repeat a practice as many times as required.

Achieving learning results in a dynamic environment, where information and knowledge flow under the student's control, adding a mental effort that the student must learn to manage. If we

add to this a poorly designed virtual environment, which generates frustration and discourages the student, then we will have a high dropout rate in the first learning process.

The teacher needs to manage a variety of tool functions, monitor student responses, present new content, and make the learning process flow smoothly. This forces him to be attentive, as he must simultaneously perform multiple tasks and functions, which requires practice to ensure that the student's learning experience is enjoyable. This is why the virtual environment is said to have a high potential for student and teacher overload. While there are several techniques to manage the mental load caused by our limited working memory capacity, there is a need to minimize the content included and instructional activities that are not conducive to learning, but most importantly to take advantage of technological developments from the design of the virtual environment.

This means using artificial intelligence, artificial neural networks, data science, programming languages, virtual reality, virtual worlds, *teacher drones,* and neurocognition. For example, monitoring the work of students can be done by a robot (drone teacher), students' questions can be answered by artificial intelligence, and assistance in practices can be provided by data science and artificial neural networks, among others.

It is recommended that in the virtual environment the content not be delivered in an integrated manner, but in a segmented manner, because doing so in discrete topics and sequencing the main concepts and related facts eases the burden on the working memory.

The software of the virtual environment can be a source of cognitive load, so it is necessary to help students become familiar with it, which is done in the induction before the start of the learning process. If we add to this the use of challenge-based and project-based learning, students and teacher will share the cognitive load to alleviate each learning process.

6.1.2 Synchronous and asynchronous communication

In virtual teaching-learning environments, teacher-student, student-student, and teacher-student-society communication take place through staggered or live and real-time tools. In the first context, i.e., the *asynchronous* one, students and teachers manage the times, because the material, contents, and responses occur at their convenience, therefore, they have time to read, process, and respond. However, under these circumstances, the learning process requires a longer period, which the teacher must take into account in the planning. That is, a learning process that can be carried out over a weekend is extended to one or two weeks because the full participation of the group must be expected. This allows students to enter the virtual environment at any time, review content and practices, and publish their answers and results.

However, many learning processes require *synchronous* communication, i.e., everyone at the same time, either because a new topic is being initiated or because the achievement of learning outcomes is being verified and validated. The challenge, in this case, is to coordinate a time and facilitate everyone listening to each other, because if the teacher cannot structure productive participation, the meeting will disintegrate into simple contributions, with a minimal line of depth, and there is a risk of derailing the topic. This is integrated into the design to provide the teacher with the tools to make these sessions fruitful in terms of participation, motivation, knowledge, and learning. For the interaction and learning process to be effective, the first thing is to negotiate agreements from the induction, so that students agree to minimize distractions while working synchronously and making meaningful use of the time.

Another feature that makes synchronous communication difficult is when the group is composed of students with diverse geographical locations and time differences become critical, so it must be clear from the beginning which time zone will be used as a reference in the virtual space. If this is not carefully managed, there is a risk that students will be reluctant to attend and the objective of the session will not be achieved. When extremes are reached, one solution is to schedule two or three synchronous sessions at different times, so that students will have more options for participation. In any case, a recorded copy of each session should be kept in case a student does not fit into any of the schedules or for some reason is unable to attend.

Synchronous learning processes use a distributed team format, i.e., respecting the schedules, cultures, beliefs, and needs of each participant; in addition, the teacher must consider the impact on his or her teaching model. While this may seem behavioral and insignificant, it becomes critical when a student is asked to participate in a meeting in the middle of the night. This reduces the quality of participation and therefore erodes community building and group motivation.

In synchronous communication, it also happens that learners get confused and overloaded, so again, it is best to set the guidelines for participation clearly and from the beginning. This is because the learning process takes place in real-time and students may not keep up with the pace set by the teacher or an advantaged student. In these cases, the teacher should call for calm and establish certain pauses to check if the silent students have any questions or inconveniences, in addition, to re-know beforehand the needs and expectations of the students, assessing their mood, and helping them feel included, encouraging them and facilitating connection and conversation with the group.

While these aspects may seem operational or technical, the designer of the virtual teaching-learning environment must take them into account to facilitate its operability. A dynamic and challenging environment should be provided in which students and teachers meet to facilitate brainstorming and sharing of practice and project results. The key in the design is to choose the appropriate synchronous media for the learning processes and to pay attention to the abilities of the participants because in this way effective sessions are enjoyed in which it is worth investing the time and effort to discover knowledge and learning.

6.1.3 Time optimization

Because in traditional education most learning processes are structured as in a production line, it seems to teachers, institutions, and students that in virtual education they need more time to develop them. This contradicts the erroneous belief that virtual education is easy; what happens is that a different model has to be created because if the idea is to automatically pass the structure of the traditional institution to the virtual one, they are going to encounter difficulties and will need additional time to solve them. The teacher cannot simply upload the material and move away from the virtual environment for a while because when they return they will have difficulties resuming the learning process. The reason is that information and knowledge change continuously and students could be more updated in that time.

This apparent lack of responsibility of teachers may not have consequences in a traditional education environment, because the curriculum is regulated and the study material is the same for years. But in virtual education things change, from a different curriculum to a different teaching model and didactics, so in designing the virtual teaching-learning environment it is necessary to involve the *droning teacher*, an artificial intelligence that is responsible for helping the teacher to

review the progress, work and responses of students so that it is kept up to date in each learning process that advises.

In this way, he responds quickly to the students' concerns, advises them, and makes suggestions for the development of the project, or simply makes his presence known to them as a support at all times. Of course, it is necessary to establish limits regarding the time of this presentation, because the virtual environment is open and available twenty-four hours a day, seven days a week, which does not mean that the teacher is also open and available. But, as in traditional education, in virtual education, there is a schedule of direct counseling and a schedule of independent work, in addition to the time devoted to analysis and group discussions. All this must be taken into account in the design of the environment, and communicated from the beginning to the actors.

Although a teacher who comes to virtual education without any previous preparation may feel that the learning processes require more time than in traditional education, the reality is that it is practically the same. The advantage is that the learning process is student-centered and the teacher changes his or her role to an advisor, tutor, or peer. The learning process becomes a matter of shared and teamwork, so the teacher must keep up to date with developments in technology and neurocognition, continuously research and learn to listen. In this way he/she will be an efficient advisor and the students will work with motivation as they feel accompanied in the process because they realize that even the teacher is learning in the virtual classroom.

6.1.4 Information overload

Some say that virtual education generates addiction of students to information, technology, and being connected, because they spend hours studying the material of each learning process, in addition to seeking different information to expand the virtual environment. This misnamed information overload only appears when the design of the virtual environment is deficient because it does not allow an adequate administration of the material and contents of each learning process, so the participants have to search on their own in the network.

This generates a dispersion of the group because the students feel anxious to find the information that satisfies the objective of the project. Moreover, in this unbridled search, they will inevitably be shipwrecked, or they will find junk information that will only harm their participation in the discussions and group analysis.

Virtual education is not the same as traditional education in terms of the material and content of the learning process. While in traditional education there is a guide text, on which all the student's work is based and which the teacher knows by heart because he has been using it for years, in virtual education the student and the teacher have access to an ocean of information that they consult and use in their way. But, although this can be an advantage, the teacher needs to structure a teaching model, and the students a learning model, to harmonize readings, analysis, and knowledge, so as not to stray from what is important, i.e. the achievement of learning outcomes.

The virtual environment is designed to manage in an organized way the information and independent work defined in each learning process, this prevents students from feeling overwhelmed and anxious to find the information that best suits what they need in the development of projects and practices. This means that limits must be set on the use and search for information inside and outside the virtual classroom, in addition to putting into practice what was mentioned about how to do research in virtual education.

When the virtual environment is properly designed, students and teachers have control over the volume of information and are not immersed in meaningless searches. However, it is advisable for virtual education participants to structure processes that help them not to waste time while in the virtual environment:

- Set specific times to read and respond rather than all day.
- Be sure of what they say and be careful what they say and how they say it.
- Do not use unvalidated information and be sure that it is useful for the project.
- Establish priorities for seeking the necessary information and categorize the need to do so.
- Entering the virtual environment only to develop learning activities.
- Download the material they consider convenient, to read at a leisurely pace and without the pressure of being connected to the virtual environment all the time.
- Do not pressure yourself to respond because other students have already done it, because each learning process has its own time and you just have to respect it.
- Work on a file outside the virtual environment and then copy the text where they need it so that the work has a better presentation and structure.

For his part, the teacher needs to design a teaching model that ensures the management, organization, and presentation of the learning processes, and use content that is appropriate for the level of the group. In addition, the teacher needs to be sensitive to the signals that students transmit, because many of these signals may suggest that they are anxious, discouraged, or annoyed about the excess of information they have to process.

The teacher sets consensual limits and deadlines for students to schedule and manage time and reduce anxiety. Proper time management is an efficient practice to avoid becoming overwhelmed with information overload, therefore, the teacher can ask advanced students, who have learned to consult smoothly, to collaborate with others and instruct them on how to develop research skills, to be more responsible in their study habits, and to be more capable of managing time in general.

6.1.5 Social presence

In a virtual teaching-learning environment, social presence is experienced both by the sensation of *being* in the environment and by the sensation of *not being* in it. *Being* occurs when the student responds with energy and attention to stimuli related to the learning process. Therefore, it is convenient to design virtual environments that capture their attention, which improves participation and, consequently, their *presence* in the environment. Students need to feel a sense of immersion that convinces them that they have left the real world and have entered the virtual world. That presentiality is the measure to ensure that they are in a different place from their physical location while navigating and socially sharing the virtual environment and participating in the programmed activities.

In traditional education, students share the physical space of the classroom, and their presence convinces them that they project themselves socially and emotionally, as real people, through that space. In virtual education, social presence is associated with greater social interaction online, where teamwork takes place because the whole group participates. This collaborative learning reinforces social presence, as all participants get to know each other, evidencing that the virtual environment really exists and that they are there. Consequently, if everyone re-knows everyone else's presence, the stimulus that everyone *exists* in the environment is reinforced.

Hence the importance of designing virtual teaching-learning environments that allow students to immerse themselves in the educational environment and enjoy the contents, either individually or in collaborative work teams. To achieve this, the environment must produce an affective experiential illusion that disrupts the attention, motivation, and imagination capabilities of the students. Synchronous real immersion provides a cognitive framework in which students perceive each other, as well as the teacher because they *are* always on the shared screen. This motivates introverted students not to assume a passive role in learning because they feel integrated into a group where they are listened to and where their contributions are taken into account.

As students overcome invisibility and assume social presence as a representation of their time in the virtual environment, they actively participate in discussions and practices, while creating a shared memory of incidents, events, and accomplishments. In a well-designed virtual environment, the camaraderie and social presence, so much claimed by traditionalists, are successfully achieved through the fusion of technology and the teaching model. There, the growth and recognition of each student as a person and others are integrated and integrated, because, in the virtual classroom, the cognitive development of social and moral interactions is shared in the community.

Virtual communities are made up of groups of people interacting around a shared interest, in which interaction is mediated by technology and guided by protocols and rules. This is what happens in a virtual teaching-learning environment because the group of students and teachers meet with the interest of developing learning processes. To achieve this, the virtual environment is designed to facilitate interactivity as a continuum, so that participants perceive social presence, social reality, co-presence, and a sense of being. A well-structured environment promotes interactive responses and socially meaningful interaction, whereby the community measures, builds and maintains its relationships, which in turn generates the interest of participants to continue interacting, support others, and accept them as individuals.

With the idea of reinforcing the links between students in the community, the virtual environment must allow the simulation of experiences that they could have in the real world and the creation of convincing experiences that they do not experience there. In this way, learning is experienced as a social activity and is distributed both between people and between technological developments.

6.1.6 Significant learning

Society continually speaks out about the education that students receive in this century, and a widespread idea is that they do not seem to be learning much. But a deeper analysis, such as the one presented in the research of [2, 3, 55], shows that they are learning, but they are not learning the *right* things, the things they need to learn to address the problems of the New World Order. This is because the content-and teacher-centered teaching approach of traditional education does not train them or equip them for those things. Therefore, a more meaningful way of educating students needs to be designed, i.e., a student-centered, learning-centered approach to teaching is needed.

Based on this premise, in the design of the virtual teaching-learning environment, the theories on teaching are incorporated, so that students perceive the learning processes as good, useful, and appealing. This is not easy and requires engineers, educators, institutions, students, and society to integrate into collaborative work teams to find out how to do it well. A good learning process should: 1) challenge students to learn in a meaningful way, 2) apply active forms of learning, 3)

make teachers care about the subject, about the students, and about designing a teaching model that enables meaningful learning through interactive activities, and 4) integrate a feedback and verification and validation system for learning.

One of the things that virtual education has done is to demystify the taxonomy of educational objectives [70], particularly that of the cognitive domain, as the only way to distinguish between types of learning. In the 21st century, these classifications hardly apply, because people, companies, and society need students to develop other important types of learning, which do not easily emerge from this taxonomy, such as learning to learn, leadership, interpersonal skills, ethics, communication skills, character, tolerance and the ability to adapt to change, among others. This supports the need to promote and develop in students meaningful learning defined in terms of change.

This is simpler than one might think, because, for learning to take place, the student needs to manifest some kind of lasting and important change in terms of his or her life project. The virtual teaching-learning environment is designed to help teachers structure learning processes aimed at helping students develop:

1. *Basic knowledge*. The objective is that they know something, that is, that they develop the ability to understand, comprehend and apply knowledge, a concept that many teachers associate with the so-called *general culture*, under the argument that the student is a social being and, therefore, attends meetings and encounters where he/she needs to *know* to participate. The student must be able to apply basic knowledge in situations that require it, whether intellectual, physical, or social. This requires the development of critical, creative, and practical thinking to give meaning to learning.

2. *Integration skills*. Because if students identify and understand the connections between different ideas, they develop an important type of learning. This allows them, for example, to integrate what they learn in each learning process to achieve learning outcomes that qualify them as professionals in a specific area.

3. *Understanding the self*. A basic goal of meaningful learning is for students to learn about themselves and others as people while discovering the personal and social implications of learning. In this way, they develop skills to understand themselves and to imagine the vision of what they want to become. But they also gain a better understanding of others, get to know them better, and interact with them effectively.

4. *Accountability*. A well-designed and implemented learning experience helps students to become more responsible in every way and to care about making better decisions. Also, when they care, they trigger internal processes that give them the energy to go deeper and make knowledge part of their lives, so learning takes on personal meaning.

5. *Abilities to learn to learn*. Understanding that learning is for life and that we must always be predisposed to learn from any situation, students must learn to learn. The learning process should guide them to be better students and people, to participate, discern and investigate at any level. In this way, they continue to learn more effectively for life.

The interrelation of these aspects means that learning is synergistic, so the virtual environment must allow teachers to develop them harmoniously, without having to give up one to achieve another. The idea is that each student achieves meaningful learning to improve their performance,

so the teacher helps them learn to use the information and concepts of a learning process, which allows them to perform better in problem-solving and, at the same time, to improve their enthusiasm for learning. But learning does not stop there, because the student will have to be able to efficiently relate all the learning processes, to make it easier for him to see the importance of each one separately and to give meaning to what he learns.

6.1.7 Integrated learning processes

The virtual teaching-learning environment is a medium that helps teachers to design and present integrated learning processes, i.e., a process away from the traditional list-of-subjects and list-of-activities approaches so prevalent in traditional education. Since the focus of virtual education is on learning, the teacher, based on the curriculum, is responsible for deciding what is quality learning and designing a learning process to achieve it.

The integrated learning process is a relational model, not a linear model, which is estimated from the design of the virtual environment and which must: 1) be *simple*, so that teachers remember it easily; 2) be *holistic*, that is, unfold and reveal its complexity without additions; 3) be *practical*, in the sense of identifying and describing what needs to be done without unnecessary embellishment; 4) be *relational* so that it shows the interactive relationships between key components; and 5) be *normative*, that is, provide specific criteria for determining whether or not the learning process is desirable.

The key to an integrated learning process is that the dimensions of learning outcomes, analysis, discussion, verification, and validation are integrated so that knowledge generation and practice activities reflect and support each other. The general assumption is that, for certain learning processes, some or some of these dimensions are more important than others. But an integrated learning process should identify all of them and guide the teacher to integrate them into his or her teaching model. In any case, in the design of the integrated learning process, the teacher needs to take into account certain aspects that the virtual environment facilitates:

1. *Description of the context*. Because to get an idea of the context in which he/she assesses the learning, the teacher is aware of issues such as the number of students, the level of the learning process, the synchronous and asynchronous work time, the verification and validation guidelines, and the scope of the practices, among others.

2. *External expectations*. Because the learning outcomes of each learning process are part of a broad framework in which they are integrally related to the learning outcomes of the professional profile. That is why it is convenient to know again the expectations of society, families, and companies, and what they expect from the future professional.

3. *Multidimensionality*. Not all learning processes have the same nature, i.e., they can be purely theoretical, practical, theoretical-practical, convergent, or divergent, so the teacher needs to identify these dimensions and reflect them in the design of the learning process and his or her teaching model. In addition, since disciplines are dynamic, after designing the learning process and teaching it, new concepts may appear that the teacher must integrate, and the design must allow for this without much difficulty.

4. *Re-awareness of learners*. Every learning process involves the participation of students who differ substantially. Unlike traditional education, where learning processes are designed assuming that all students are the same, in virtual education this matters and the teacher

designs the learning process, the teaching model, and the didactics based on the re-knowledge of the students in the virtual environment.

5. *Academic challenges*. Again, unlike the traditional classroom where the teacher assumes that learning processes do not change and do not generate academic challenges, in virtual education these challenges are permanent. This means that the teacher must be concerned about discovering them and keeping them in mind when designing the learning process. In other words, before developing a significant learning experience, he/she must identify the special situation that deserves more attention and challenges him/her and the students.

As an immaterial context of interaction, the virtual teaching-learning environment is structured on an intangible architecture to support and organize user interactions in the achievement of integrated learning. In this way, it is an organized context in which students interact using their senses, which implies the need to design it as a system in which they can interact, even if they are spatially dispersed. The reality is that, individually or in combination, characteristics such as intangible architecture, sensory fragmentation, and distancing are what make the virtual environment and what best support the development of integrated learning processes.

6.1.8 The spoken word

Although for many people virtual environments are a recent technology, the truth is that their genealogy goes back many years. This assertion is argued on the fact that a conversation by video, *chat,* or mail is no different from one that takes place by phone or through a letter. In either case, information is shared, the same assumptions are made and, to balance the absence of audio, image, or contact, the participants employ some virtual technique. That is why it is not convenient to discard how mankind has always communicated but to take them into account when virtualizing communication between people in the light of technological developments because to consolidate, every new means depends on a previous one.

The design of virtual teaching-learning environments involves a particular understanding of the media that were previously used for communication, and instead of generating a historical rupture between the real and the virtual, it is a matter of re-evaluating the medium as a continuous process of virtualization. What is happening is that the *old* means of communication, such as the spoken word, have not been displaced, because they are essential for effective communication in virtuality, where the sense of presence depends on the participants using it.

If we accept that a spoken word is a form of virtuality that has always been present, the virtual environment needs to use grammatical rules to locate the students and the teacher, in addition to creating a space for communication, because the relationships between them are temporal and spatial. Although grammar is different for each language, in all of them it constitutes a virtual temporality so that in the virtual environment events, phenomena and processes are inserted that respect the logic of the source language in terms of the sequencing of words. The reason is that language is the original form of intangible architecture of communication, which survives and mixes with those used in virtuality.

The spoken word implies a slight distancing, whether in the real world or the virtual world because people transmit information and knowledge that they obtain from experiences lived in specific times and places, but that they communicate in other times and places. This is important for the design of a virtual teaching-learning environment because it is feasible that this subtle distancing fragments the senses of the participants when listening to the sender's message. It turns out that

when listening to the spoken word, the ear has to interpret the message by taking on the functions of the other senses to translate it, from a specific time and place, into virtual sensations of real or virtual time and place.

In virtual education, virtual architecture, distancing and sensory fragmentation coexist to give meaning to the message, so the virtual environment takes these aspects to control the here and now, while awakening sensations and thoughts in those who listen. This facilitates the discovery of information, the generation of knowledge, and the achievement of learning because students *get lost* in the story transmitted through the spoken word.

In spoken communication in the virtual environment, the teacher needs to be attentive to what is being said, because some conversations are subject to the interpretation of space-time by the sender and the receiver. In the virtual environment people tend to converse as if they inhabit the real world, that is, they use a relative frame of reference. But, while in the real world, it is easy to express and understand concepts such as here or there, because the spoken word relies on the body and gestures to make sense, this does not happen in the virtual world. In the virtual classroom, it is normal to use an absolute frame of reference, i.e. intrinsic descriptions, which depend on and help to imagine the virtual space. That is why it is said that the spoken word fragments the senses because communication is based on creating imagined, ideal or hypothetical spaces as a strategy to make sense of the message.

In the same way that a person learns a language, the virtual teaching-learning environment is designed to understand and interpret the way foreign learners use concepts such as space and time when using the spoken word, and to be a kind of translator for the receivers. It may not be that simple, although an Artificial Intelligence could use artificial neural networks to achieve this, if this is not the case in the virtual environment then the teacher needs to act as a translator and structure a common linguistic landscape for all because the idea is that the message is understood.

The important thing is not to forget that language is a system associated with objects, phenomena, terrains, territories, times, places, and values that are part of the virtual world, but that many of its messages refer to relative temporal spaces anchored to the real world so that both the sender and the receivers must orient their senses to convert relative forms of expression into absolute ones, and take advantage of and support virtuality.

6.1.9 The written word

Before the emergence of writing as a form of communication, the spoken word was the predominant means of expressing and communicating thought. To give meaning to the message, the sender resorted to non-verbal information transmitted through gestures and virtual space-time representations. Writing broke this reality by demonstrating that the message no longer depends on the messenger and that the message is delivered even if the sender and receiver are in different spaces and times. In writing, the sender speaks as if coming from nowhere and the temporality of his message does not coincide with the space-time of the reading, thus creating an asynchronous communication.

Given this scenario, the virtual environment must support the written word as a durable and portable communication, that is, as a fixed spatial pattern of symbols that can *speak across* time and space. In these spaces, writing frees the message from the Spatiotemporal constraints of the spoken word, and no acted verbal construction is required to deliver the message, so the material

space-time of the sender and that of the receivers need not be the same. In the design of the virtual environment, this means structuring databases to store the written word and then making it available to the participants in each learning process.

The virtual environment is not a neutral and meaningless writing surface, but a space of relationships, whose intangible architecture is entered through reading and writing. In these environments, the written word provides spatial coordinates of language so that the written message acquires a timeless dimension free of context.

When reading the material of the learning process, students prioritize vision over the other senses and develop sensory fragmentation that facilitates their understanding of the distance from the sender. But the whole process is supported by the virtual teaching-learning environment since the technology operates as an intermediary between the written message and the students' interpretation, and thus objective learning is achieved.

In a well-designed virtual environment, the written word makes students generate lexical lists, trees, roles, and linguistic classes with different characteristics from those they generate with the spoken word. By developing this cognitive capacity, it becomes easier for them to move around the virtual space, just as they do in real space, and this mobility creates collaborative work networks, an essential component for achieving learning outcomes in virtual education. In this way, the virtual classroom becomes more than a meeting of people and things in a space, because students and teacher forge their own space and establish the conditions for the written word to achieve the task of transmitting the message.

In this space, students also position themselves and establish broad relationships to establish a common language that allows them to understand and comprehend the message of others, find sufficient information, and create knowledge, which is subsequently transformed into learning. The material recorded and shared in a unified language generates coordinates in the virtual space, where the teacher or one of the students coordinates the analysis of the reading. In this way, they reflect on a text, feel it, debate it and imagine it, because collaborative work gives them the freedom to question, criticize and reformulate anything. This suggests a virtual space different from the real space of traditional education, where there is a centralized authority that interprets and *imposes* its vision of the written and spoken word.

6.1.10 The sound

Many people assume that virtuality is the opposite counterpart of reality, i.e., that without the virtual, the reality could not exist. According to this argument, virtuality has existed since humanity began to understand reality. The issue is that human beings have a limited and abstract understanding of the real, which often leads them to identify the cognitive perception of the unreal as real, resulting in the fact that what they perceive is not the same as what it is. This notion leads to something more complicated because it suggests that each person possesses a unique reality that contains various perceived interpretations of the unreal.

In virtual education, this definition could be valid at a theoretical level, but it imposes a limitation on the opportunity to develop a conceptual understanding of technological advances. This leads to a detailed judgment of virtuality, which must be put into practice when designing a virtual teaching-learning environment. This technology is a tool in which creative design options from different dimensions converge to create immersive sensations through different media, and which in the end have the same purpose: to *generate a better learning experience for all people*. The

associations defined in this environment advocate the inclusion of visual, textual, and sound information, to blur the lines that separate the virtual from the real, and, consequently, audio becomes a necessary sensory modality for the virtual classroom.

A virtual environment needs to place the learner in a comfortable context for a situated, hands-on learning experience. As he navigates through the learning process configuration, he receives feedback in the form of sounds, confirming the performance of actions on the interface. When your immersion is shared, you also hear the teacher and peers as you perform your actions.

As the sound *discovers itself* in the virtual world and encounters a given learning process, it keeps informing and *graphing* the learner about its actions and procedures. Likewise, each achievement or error is accompanied by a congratulatory or warning sound, because, regardless of whether he is alone or accompanied in the virtual environment, the student needs that kind of *voice* that informs him of the result of his actions.

This scenario is created when designing a virtual environment, since sounds are feedback that supports the learning experience that students live, and although there is no physical relationship between action and sound, choosing appropriate sounds allows them to create semantic associations between what they do and the sound response. The difficulty for the virtual environment designer is to create response sounds for fictitious entities, such as *well-done* or *you forgot something* because they do not have physical causality and are created by logical associations to responses in real reality.

Many sounds are recordings of events in the real world that are not always easy to recreate, so the designer resorts to hyper-real sounds, with the drawback that the student can identify the sound and associate it with something different from the action he is performing in the virtual world.

This is further complicated by the fact that the sound originates from a live speaker, generating information that has to be digitized and encoded, as sound wave data before it reaches the learner, and there is usually a delay between the time the sound originates and the time the learner hears it. This is because the audio input to the computer has a stronger temporal and semantic association with the input than with the propagation. After all, it is artificial. On the other hand, virtual audio does not refer to just any sound propagated by an artificial medium but is a significant proportion of experiencing a sound in the real world.

The virtual teaching-learning environment needs to generate sensory data in the visual, auditory and tactile modalities, which leads the designer to strive to incorporate realistic soundscapes that expand the simulated sensation to olfactory, auditory, visual, tactile, and gustatory inputs through representational inferences. Certain visual representations may not require going to the point of including direct realistic sensations, such as the smell of a decomposing body, but by using indirect complementary sounds, greater realism is achieved. Although in the virtual world, a realistic soundscape mirrors its real-world counterpart, the lack of sounds that alter or compensate for other sensory modalities creates an incomplete learning experience because it does not facilitate total immersion.

It is not easy to understand the complex interrelationships that are generated between people and the environment, real or virtual, because they are fundamentally shaped by the process theory approach in the brain, but the virtual environment must allow students to explore various ways to define, perceive and interact with sound in the learning processes.

6.1.11 The image

The designer of a virtual teaching-learning environment needs to understand that the virtual classroom will not develop effective learning outcomes in students until the images in the learning processes are truly immersive. The reason is that people live between fantasy and reality, to the point that many do not differentiate between the two.

The virtual world brings fantasy closer to people so that they feel at ease in its scenarios, in such a way that immersion convinces them to live fantastic realities. However, immersion is not only of a perceptual nature but also involves cognitive phenomena such as attention fixation and voluntary suspension of disbelief, which occur, for example, when the reader is immersed in the imaginary world of a book.

Students share the virtual world with other things, for example, images, but they feel that they inhabit that world only when those things are important and have a real or potential impact, and then they become important in the learning process. On the other hand, these things also interact with the learner, so the causal efficacy is bidirectional.

This interactive connection gives the learner a sense of participation and inclusion in a world of virtual things, such as material, sound, speech, and movement. Therefore, this virtual world cannot be considered false, or even imaginary, it is only an augmentation of reality generated by technology, a basic component in the design of the virtual environment.

The designer of the virtual environment takes into account that images can be representations of the real world or representations of the virtual world, but the emotion they generate in the student is what matters. That emotion is what gives realism and usefulness to the images because the student understands that he can use them to discover information, generate knowledge and achieve learning. Therefore, in the design of the virtual environment, images should:

1. *Represent something*. The student knows something in the real world that he can associate with the image, i.e., the image reminds him of some real location. In this way, he manipulates the object in the image to find out more information, such as weight, dimensions, or its effect by including it in the laboratory practice. If the image does not represent something that the student knows, the virtual environment should offer the respective information, or induce him to find out what it is and the role it plays in the learning process.

2. *Reproduce something*. This means that the image must represent something that the student can distinguish and not a meaningless object. The fidelity of the reproduction should draw their attention to the use of the object, which is achieved by paying attention to detail and using any tool to make the object meaningful in virtuality.

3. *Reflect presence*. It has been pointed out that the student feels that he occupies a place or that he is in the virtual world only when he interacts with it. That is why the image needs to reflect a presence, that is, to *be* in the virtual world because an image that represents something and reproduces something is useless if the student cannot manipulate it. After all, it is not part of his learning experience.

An image designed in this way offers the learner a real learning process in the sense that it represents something familiar. But if that something is unfamiliar, the virtual environment and the teacher need to provide the missing information, because the environment in which the image

is placed could be completely virtual, real-local, real-remote, or virtual-real. Also, images should represent recent things, unless the learning process deals with historical issues; but if the image represents a real living being or a real landscape, that image should be as close as possible to the appearance of the being, because this makes the learner more familiar and makes him curious to delve into related details because he perceives veracity in it.

The immediacy of the representation is also important since the students have to see the same image at all times and it does not change from one scenario to another. It may happen that one group is looking at an image of the real world, but in the same subject, another group is looking at a virtual image of the same object, in which case there must be no marked differences between their points of view.

Another characteristic regarding images is that they should be flexible, in the sense that students can intervene in the context and change the presentation of the objects during their learning experience. The virtual teaching-learning environment is designed to manage these situations, for example, when students read a virtual text they can use bookmarks to highlight parts of it, or *enter* it and experience the content from the first-person point of view.

In any case, the student's interaction with the objects should provide him/her with the possibility of manipulating them as needed, with limitations in terms of not losing sight of the learning outcomes to be achieved in the learning process. In addition, when the student does not finish his experience in a session, the virtual environment saves the re-configuration so that when he returns he can continue where he left off.

6.1.12 The aroma

Humans receive a continuous flow of important information about the environment through smell and use it to make decisions. Smells indicate everything from danger to enjoyment, and even help identify other people, and the sense of smell has evolved to differentiate between thousands of aromas. Although these are natural functions in the real world, they suggest possible applications in the virtual world, where they are used to generate emotional states or modify others that predispose students to experience learning processes.

Many video game designers take advantage of the potential benefits of integrating smell and develop realistic simulated aromas, although it is still a developing field of research and the evidence that they succeed in modifying players' moods is scarce. In any case, designers of virtual teaching-learning environments must remain attentive and experiment with the results, because the goal is that students attend learning processes close to a real experience.

Among other things, students need to understand that subjective odor perception is a complex process that is often described using dimensional relationships, such as pleasantness, familiarity, and intensity. Although these relationships are important to integrate into a virtual environment, pleasantness is the most salient in people's perception. That is why the pleasantness of a scent is the dimensional relationship that has the greatest influence on the predisposition of students to participate in a learning process.

What makes the integration of scent in a virtual environment complex is that people are driven by associations learned in the real world, which makes it individual and particular. Different factors have varying effects on the human perception of scent:

1. *Intensity*. This factor is associated with the speed of activation of neurons, where a strong smell generates neuronal impulses and a predisposition to do something. Beyond the physiological, there is a relationship between intensity and pleasantness and, although people can separate them, when the scent is pleasant and familiar they forget about the intensity of it.

2. *Interference*. Research has shown that people confuse scents when the information they perceive by smell is interfered with by the information they perceive with other senses, especially vision. Therefore, images have to be congruent with their representative odor, and the design has to properly synchronize olfactory and visual cues to guide the learner's decision-making.

3. *Experience*. People tend to relate a scent with lived experiences, which generates in them an emotional response that induces them to act. That is to say, the pleasant or unpleasant perception of the smell is linked to an emotional response, which depends on the personal experience that recalls that smell. Because of this, in the virtual environment, it is necessary to introduce sequential scents in the learning process, so that students trigger the expected emotional state. Therefore, a good practice is to know in advance the emotional effects that the scents have on each participant in the virtual environment, before including them in the learning process.

4. *Cultural stratum*. People's experiences are closely linked to their cultural strata and culture, which leads them to respond in different ways to scents. The designer of the virtual environment must also re-acquaint himself with them beforehand and evaluate different scent applications until he finds the ones that receive the best response from the learners.

While understanding the complexity of introducing aroma into virtual teaching-learning environments, designers need to ensure that the process they use takes into account certain issues if it is to be successful with students:

1. *Standardize the presentation*. This refers to structuring a standard method for including smells in the learning processes because the smell is a trigger for the learners' motivation to participate in the learning process. The method should be the same in all virtual scenarios so that the learner does not perceive changes that confuse him/her from one environment to another. The lack of standardization hinders the achievement of learning outcomes because this confusion discourages and demotivates students.

2. *Connecting scent to emotion and cognition*. One of the objectives of integrating smells in a virtual environment is to awaken emotions in students that predispose them to learn. Therefore, it must be taken into account that the connection between smell, emotion, and cognition has to be studied and validated process after the re-acquaintance of the students involved in each learning process.

While these and other factors have effects on people's emotional response to odors, it has been found that humans regulate odor perception to enhance the response, i.e., they adjust their responses to the various odors in each environment.

This adaptation allows them to respond appropriately when they perceive a new odor or when its intensity is higher than that of others. Likewise, when they are repeatedly or prolongedly exposed to a particular odor, they easily recover their sensitivity in the absence of the odor.

All this is important when designing a virtual teaching-learning environment because the level of student motivation improves or not their performance in the learning process. While scents affect motivation, workload, mood and emotional state also have an influence, although motivation depends largely on the person, the learning process, and the educational level.

The designer must keep in mind that all design emerges in the brain in response to input information through the senses. But in a virtual teaching-learning environment, even if the designer includes what has been described in this chapter and much more, creativity only emerges from his or her experience. It is possible for the design to be good from the numbers, but not pleasing to the students because they have preconceived notions, perceptions, or disabilities that do not allow them to *feel it*.

Hence the importance of the designer's experience, because he can develop his creativity by thinking about the structures, masses, and surface textures he uses; from feeling the bidirectional influence between sounds, spaces, and surfaces; from imagining the sensation of temperature, touch, and pressure on the senses; from perceiving how the aromas of materials and activities are related in the space of the virtual environment; and from integrating the vision and taste of what he perceives in the real world to find colors, aromas, and shapes that are appealing to users.

A well-designed virtual teaching-learning environment offers all this information to the student because the design is communication. That is why it does not matter where the virtual environment is designed or how much sub-realism is involved, what matters is the message, that is, the message that virtual education wants to convey to students and its meaning: *learning*.

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7. INTELLIGENT EDUCATION

The Intelligent Education program is an imaginary that is part of a research agenda focused on the developments of neuroscience, neurocomputation, neurocognition, and Computational Sciences, to design, structure, and implement intelligent learning algorithms to innovate education in the New Age. The work starts from a conceptualization of the relationships between learning algorithms, neurocomputing, and new learning spaces. The program combines transdisciplinary developments and discoveries that these areas have achieved so far to offer intelligent education from information processed with algorithmic models.

At the core of the program, the socio-technological imaginary of an intelligent virtual classroom is built, where structured learning processes are developed from the knowledge generated from data science and cognitive computing, to make virtual education institutions intelligent entities. As an imaginary, intelligent education constitutes a characteristic instance of emerging virtual institutions, which is oriented from neurocomputational processes structured from discoveries such as brain plasticity for artificial learning, and used in the virtual classroom as spaces where interactions between human cognition and artificial brain functioning constantly flow.

In this century, educational institutions are thought of as environments conducive to intelligent learning in which, by taking advantage of computational capabilities and algorithmic development, it is possible to monitor, know and adapt their educational model to the demands and needs of the new category of students. As Computer Science demonstrates, the intelligent institution is a global environment structured by taking advantage of the capabilities of new technology devices and the development of complex algorithms; that is, a programmable environment fed by student data, which processes the algorithms in powerful computers.

This will become a reality when the institution evolves as an intelligent institution and becomes a sensitive space, where students are accepted as people who learn, but who knows, with their reflective awareness and who seek to enhance their skills and abilities to develop their cognitive capacity.

This chapter describes the Intelligent Education proposal, a program focused on data science and the developments and discoveries of Computer Science, neuroscience, and neurocomputing, with the support of technology. The idea is to structure virtual classrooms where learning processes are *programmed*, that is, intelligent spaces where cognitive computing and technological developments are combined.

These principles are based on highly algorithm-dependent techniques for the analysis of automatic learning and, based on student performance data, different models are designed, trained, and simulated, combined with cognitive computing and algorithms of artificial neural networks and neurocomputing. These models are based on scientific knowledge of human brain functioning, to personalize and optimize the classroom environment and develop intelligent learning, both individual and group.

Intelligent algorithms form collective models of learning processes that can be potentiated in the intelligent institution as learning environments. The contribution of this proposal ranges from the identification to the dissemination of the algorithmic learning process as an integral part of

intelligent virtual classrooms. The imaginary is a model that institutions develop in an environment dominated by software and algorithms, where computational forms will be increasingly intelligent.

This type of education is an instance of teaching governed by neurocomputational processes arising from the discoveries of the brain's flexibility for learning and supported by a computational power beyond human perception and consciousness. As a cognitive space, it can understand the morphology of the brain and its cognitive functioning, re-imagining a subject that learns more intelligently. For those who dream of neurocomputing being able to read and model the brain, the intelligent education agenda could materialize their expectations, because in the program new computational applications are designed and developed while re-imagining the human being from algorithmic models in terms of cognitive computation and programmable functions.

In various investigations associated with an intelligent education type program, initiatives are developed in which education is perceived as a social dimension, located in an institution mediated by technological developments. In this dimension, the academy acts as a code space in which algorithms are integrated into the functioning of the environment, and where the code-space concept translates its functioning through recursive coded processes. In these scenarios, the programmed institution is a prototype of code space, in which the cognitive functions are assumed by software systems in charge of using and transforming, through intelligent algorithms, the data collected from the experience, the cultural stratum, and the expectations of the students, to model virtual teaching-learning environments and improve their performance.

In other scenarios this assumption of the institution does not have the same level of attention, preventing the vision of intelligent education from establishing a direct relationship between software, algorithms, and students, not only to train them intelligently but to make that scenario a programmable space as a learning environment, where the main role is assumed by machine learning and cognitive computing algorithms, in such a way that they learn from students and their imaginaries through data science.

In this sense, it is also necessary to involve the socio-technical imaginary of the intelligent education program, sustained in the collectivity of the school context and institutionally stabilized to develop joint projections of subsequent desirable moments in the virtual classroom, built from the learning of intelligent algorithms designed as technological processes. At that moment the code-space of the intelligent institution becomes a socio-technical imaginary, materialized and operationalized through innovative intelligent algorithms and specific technological-educational practices.

In particular, the program focuses on education as a key organizational actor, which prioritizes learning analytics and cognitive computing mediated by algorithms. In addition, it articulates an imaginary for the school dimension with operational practices based on challenge-based and project-based learning, that is, it becomes an algorithmic model for the achievement of an education adapted and achievable with technological developments because algorithmic forms of learning and the discoveries of neuroscience and neurocomputing are an integral part of its operation.

From the methodological point of view, investigating this imaginary implies a review of diverse sources, in addition to tracing the different logical connectors between specific scientific knowledge claims, people, technical applications, and the imaginaries of an institution where the developed algorithms are operationalized. But care must be taken, because this material is not always easy to analyze and triangulate because much of it is publicity without a solid foundation

that feeds, for example, the aspirations of smart education software providers, even if they represent alternative smart institutions. Likewise, research should inquire into the learning and neurocomputational models that underpin the achievement of automatic cognition, as well as developments in cognitive computing, critically considering their misuse and the possible consequences of generating behaviors and practices that undermine the imaginary of intelligent education.

In any case, many of the findings achieved so far are algorithmic processes that work, but that acquire experiences of previous moments from their development in laboratories while re-orienting the path that leads to a later moment in the imaginary of intelligent education.

Another issue is that much of the empirical data related to the material, collected on the imaginary of intelligent classrooms, is not readily available, so when analyzing the findings, one has to take into account the different ways in which algorithms participate in the structure of an intelligent classroom, with the idea of promoting the brain-code-space principle. What can be validated through data science is that, under this principle, virtual classroom environments become increasingly programmable as spaces that rely on coded models of cognitive functioning, while being leveraged as spaces for the achievement of adaptive learning through neurocomputational algorithms.

7.1 INTELLIGENT ALGORITHMS

Intelligent learning and cognitive computing are fundamentally based on algorithms, from which a body of research in Computer Science emerges where they are analyzed as social products because they can be used in specific environments. Hence, some researchers [71] characterize them as: 1) *black boxes,* which are masked in intellectual property and their code; 2) *heterogeneous and emergent systems,* which are constantly being refined, modified, and updated; and 3) *complex*, unpredictable and fragile *systems*, because many times and when they are poorly coded they get out of control. The complexity in them is such that they come to do things and exert material effects on them, machines, and people. This has led them to be integrated, almost naturally, into everyday social processes where they reinforce, maintain or model the social dimension of the world, knowledge, and data science.

Research in this emerging area must, among other things, lay the groundwork for verifying such claims, because they lead to conclusions of simplistic technological determinism and to identifying intelligent algorithms as mere products of social practices. That is why in this analysis algorithms should not be conceived only as abstract technical achievements, because, although they are seen as cold mechanisms, they also involve warm human and institutional choices. It is important to examine the intelligent algorithm as a technological development, alongside human complexity and social interactions, in a way that highlights the intricate functional interplay of models, goals, data, variables, indicators, and outcomes involved in them and necessary for data science, while being an important asset of intelligent learning. In this sense, the area is as important an object of research as the underlying human models, because they operate within a fully algorithmic social world.

The models of human learning and cognition, embodied in learning and neurocognition analysis systems, developed in an intelligent learning program are described here. But it is clarified that the analysis of the technical complexity of the algorithmic systems of such a program is beyond the scope of this book, although the available literature related to the assumptions, models, and desired results for the operation of the algorithms is analyzed. This is part of an imaginary whose

goal is to build the desired school environment for intelligent learning and which would have as its central brain an intelligent algorithmic machine [76, 77].

7.2 DATA SCIENCE

The intelligent learning analytics software product is designed to allow learners to track their digital data in real-time, and to provide them with automated forecasts of their progress at a later point in time. This learning analytics is an emerging transdisciplinary field that integrates a promising conjunction of statistics, computer science, data science, machine learning, neuroscience, neurocomputing, and neurocognition.

In all of this, intelligent learning analytics is based on both techniques and applications [78]. Techniques involve algorithms and models to perform analytics, while applications involve how the generated ideas are encoded into software products to improve teaching models. To exemplify these definitions, an intelligent algorithm, which delivers content recommendations for a learning process, is classified as a technique, and a technique such as a dropout prediction generates an application, such as content personalization that is used to mitigate the risk of dropout.

Thus the intelligent education program becomes important because it is the key organizational developer of learning analytics applications and techniques. After all, the program harbors analytics principles arising from developments in Information Technology. The basis of the program is a set of assumptions, available in real-time and contained in the large volumes of educational data about how students learn and progress, that use data analytics to improve the achievement of learning outcomes.

The objective is to convert data into information for decision-making and the creation of school administrative policies, as well as allow the actors in the teaching-learning process to identify the techniques and applications that offer the best results to achieve intelligent learning, and where the institution's investment should be directed. This contribution of intelligent algorithms offers institutions the possibility of structuring intelligent educational processes for the New World Order.

In the development of the imaginary of an intelligent institution, it is necessary to emphasize the need to use *academic analysis* in the classroom, that is, to apply data science to know the efficiency and effectiveness of each learning process, and *learning analysis* with data science to know, interpret and use the actions and manifestations of students for the benefit of intelligent learning.

Based on the data collected, the analysis process uses *predictive algorithms* to model the subsequent moment of learning, and *prescriptive algorithms* to automate the appropriate pedagogical processes in each case. These intelligent algorithms allow institutions to detect patterns reflected in the data, project potential outcomes, and make informed decisions based on the models and projections.

With the establishment of the intelligent institution, more data are collected in real-time about the activities and manifestations of the students, and predictions and models of the expected learning outcomes are made, while didactic and methodological actions are projected to make them a reality. The idea is to build a virtual teaching-learning environment for the institution, designed as a neurocomputational system to collect, aggregate, and analyze the data generated individually and in the interactions between the actors involved in the teaching-learning processes and,

subsequently, to write the necessary intelligent algorithms that allow data science to use them [79].

This system is in charge of operationalizing the intelligent education program and converting in real-time the data collected in the performance processes of the actors, focused on data analytics, algorithmic analysis, and feedback in the virtual classroom.

In the modeling approach to the operation of algorithms intelligent, learning is based on the modeling techniques of the actors in the teaching-learning process. In this regard, and from findings in data analysis [80], a view of the actors' behavior can be designed using only models and algorithms. But one must also model the learner, the cognitive process, the behavior, and the probability of the achievement of learning outcomes, among other components of the teaching-learning process.

The domain model, i.e., the mapping of the body of knowledge of a discipline, is an important element in these learning analytics systems. In the end, and once these models are combined, you have the raw material for predictive modeling of actors' progress, where algorithms acquire meaning for intelligent learning design and predictive analytics.

On the other hand, *machine learning* consists of software systems based on adaptive algorithms, deep learning techniques, and statistical models to analyze data, anticipate or predict the actions of actors at later points in time, and use data science about their events, actions, behaviors, beliefs, and desires. It is then used in probabilistic predictions of later moments, to make decisions and take action.

This predictive practice depends on a broad transdisciplinary knowledge of mathematics, statistics, logic, and Computer Science, rooted in the predictions and configurations of intelligent learning, which engineers, mathematicians, statisticians, and computational scientists use daily.

Another important issue in the intelligent education program is that the query oracle arises from the interaction between the algorithms and their underlying models, built from data science. The algorithms are built after developing each model, i.e., after formalizing each problem and its educational objective in neurocomputational terms. To make them work, they must first be *trained* with existing data, so that they *learn*; then they are constantly re-trained through tailored iterative processes of monitoring, tuning, revision, and optimization.

These models and training data are constructed and operated according to values and assumptions in the design so that intelligent learning analytics depends fundamentally on the construction of models of learning actions and learning processes, which are then subjected to algorithmic processes designed to learn. In turn, the models emerge from complex socio-technical practices that are developed in the school dimension and are embedded in the methodological commitments, assumptions, values, and thinking styles obtained from data analytics and the participating actors.

Although the specific internal practices of the intelligent education program are beyond the scope of this book, the different resources consulted define particular sets of assumptions in the analysis of learning and machine learning algorithms, which circulate in the context, in the actors, and the institutional dimensions. In other words, data from social life, both in the institution and in the virtual classroom, are leveraged for the algorithmic practices required by the program.

Based on the assumption of the intelligent institution, the different aspects of the teaching-learning process are modeled, such as the actors and their behavior, to generate predictions and possible results at later stages. Likewise, the institutional processes involved are examined to shape the data for the re-training of the machine learning algorithms and to generate information on the behavior of the actors, and then the teaching-learning process is verified and validated to make it more appropriate to each modeled situation.

7.3 THE INTELLIGENT VIRTUAL CLASSROOM

An emerging issue in the program is learning analytics and machine learning techniques, associated with cognitive-based learning systems, which rely on neuroscientific innovations, neurocomputational developments, and intelligent algorithms. The application of these systems in virtual education is part of the idea of massifying educational neuroscience in learning environments. Some of the achievements of this massification are evidenced in the increased influence and reference in the literature of terms such as neurocomputing, neuroeducation, neurocognition, and intelligent education, as part of an effort to take advantage of neuroscientific discoveries and developments about learning, to feed the idea of the educational revolution in the New Age [55].

In some neuro-educational developments, the use of the functional architecture of the brain as an algorithmic or computational process is evident. If intelligent education takes advantage of the accumulated experience and the results of work in cognitive computation, it is possible to design algorithmic models of brain functioning that encourage researchers to work on neurocomputational systems to intervene in the teaching-learning processes.

The goal is to develop computational systems capable of solving problems as a student is expected to do and, if possible, to model them to develop the drone teacher and to become the digital tutor to support the processes in the virtual environment. This goal is beginning to materialize with the development of cognitive-based learning technologies, refined from the knowledge of the brain, with which cognitive modeling for intelligent learning can be achieved.

Algorithms already exist that function more like human brains than software programs, a technology that is integrated into the virtual classroom as an aid to develop or enhance students' cognitive abilities. The promise is that these algorithms learn from the user, taking advantage of the data collected from their virtual education activities, to adapt them and to respond at a later time to the demands, needs, and preferences of each user, in a more *human* and less machine-like way. Experimental cognitive systems, developed from these algorithms, learn at scale, reason meaningfully, and interact naturally with people, thanks to involving human qualities of self-direction, common sense, and ethics [81].

The process requires the formation of a transdisciplinary research center in cognitive computing, composed of engineers, software developers, computational scientists, neurocomputational scientists, data scientists, neurocognitive scientists, and educational researchers, who conduct basic and applied research in the area. The goal is to develop cognitive computing with *human qualities*, linked to an agenda for intelligent education to leverage research and development around intelligent algorithms, artificial neural networks, and data science in the analysis and interpretation of large volumes of data.

The work on cognitive computing refers to the brain as a *data processor*, a principle that is used to develop decision support systems, with computers that process natural language and

unstructured data to learn from experience, just as people do, and not as so-called *expert systems* do. Among the contributions and developments are the work of Beudert and colleagues [71] and Davenport and Kirby [72], as well as IBM's cognitive supercomputer [73], a cognitive technology that processes data and similarly generates information as humans do, because it understands natural language and builds hypotheses based on evidence while learning in the process and becoming more intelligent by learning from users and interactions in previous moments, to generate new information.

Mention should also be made of progress in cognitive computing research, which seeks to develop intelligent algorithms that simulate artificial brains. This area provides a neuroscientific vision in which the brain is viewed as a synaptic memory system determined by computable neural patterns, and not as human-engineered architectures. That is, the goal is not to build an *artificial brain*, but a computational model from what is known about it. This is because the goal of cognitive computing is to emulate the brain's abilities to perceive, act and learn intelligently, as would a sequential repetitive machine.

The intelligent education program takes advantage of these developments and innovations to design a new computational model for virtual education, replacing programmable approaches to designing algorithms and outdated machine learning. Moreover, while such an algorithm relies on program and data training, an intelligent cognitive computing system can process and learn from natural language, user interactions, and unstructured data, emulating the neural networks of the brain.

The path of research in this field is evolving from neuroscience and neuroanatomy to supercomputing and new computational architecture, with new programming languages, algorithms, and software developments. In other words, a technology that dynamically learns from interactions and experiences finds correlations, creates hypotheses, remembers, and learns from its results; an intelligent learning process that tries to emulate in silicon the functioning of the human brain.

To take advantage of the advances in cognitive computing in intelligent education, specific programs must be developed to transform the educational system, away from the assumptions and misrepresentations that continually arise. In this way, intelligent virtual classrooms become an imaginary application of cognitive computing, which is part of the scenarios envisioned for the subsequent moments of the intelligent education program, developed in real-time, responsive, predictive, and highly personalized to the needs and demands of the new category of students [3].

Virtual classrooms are intended to use cognitive computing and data science to capture and analyze, in real-time, amounts of student data to circumscribe their learning experiences and to *learn to teach*.

In this imaginary, the student learns through cognitive-based learning systems, which allows for unprecedented instrumentation of the teaching-learning process. This is possible because cognitive computing helps to calculate how each student learns and progresses and to create a flexible system that continuously adapts and adjusts the teaching-learning model to the reality of the classroom.

Using adaptive learning software and intelligent algorithms, with which the programming and automation of corrective activities are developed, in the virtual classroom learning is personalized and the learning results of each student and their progress are known in real-time while

discovering changes in content, didactics and the verification and validation of learning. This is because they are structured as intelligent and interactive systems, in which neurocomputational knowledge is combined and channeled through neuro-technologies to achieve intelligent learning.

Moreover, it learns from humans and naturally interacts with them, while it is constantly developing thanks to advances in neuroscience, progress in neurocomputing, and the development of intelligent algorithms that model the different aspects of the brain. Research shows that in the cognitive neuroscience-neurocomputing concurrence there is a unique opportunity to rethink educational theories [82], but, above all, the traditional pedagogical model, while presenting new and innovative principles to guide how to structure content, didactics, and the verification and validation of learning.

Among the developments achieved are *automated cognitive learning contents*, *virtual cognitive tutors,* and *ubiquitous cognitive assistants* integrated into adaptive learning systems, developed from intelligent algorithms and based on knowledge generated from neuroscience and cognitive learning theories, which are used as *fuel to* increase the computational power that is put at the service of the student's cognitive process. At the moment, virtual cognitive tutors (drone teachers) are used as a complement to the content of the learning process, but at a later stage the idea is that they will completely replace them as cognitive agents, because, quite simply, they will do a better job. After all, they understand in greater detail the needs of the students.

These imaginaries of the virtual cognitive tutor and the ubiquitous cognitive assistant are the foundation for a new genealogy of thought and knowledge for the automation of the teaching-learning process, but, more importantly, they presume the emergence of a neurocomputational theory based on brain models that are put at the service of intelligent education. The promise of the virtual classroom that learns refers to an intelligent environment where the student develops and potentiates their cognitive faculties because the virtual environment is designed based on neurocomputational and neuroscientific discoveries and developments.

Cognitive computing is not a technological system with human qualities, but a huge step toward the next generation of human cognition, in which people will think and reason in powerful new ways. While today's automated cognitive systems are brain-inspired machines, cognitive computing *will inspire the brain*, increase its reasoning capacity, and reshape the way it learns.

The imaginary of intelligent learning implies rethinking the virtual institution as a computational space inspired by the brain, which students attend to develop or enhance their abilities, capacities, and skills. In that space, the cognitive classroom becomes an ecosystem of individual cognitive environments, i.e., specialized software agents that work with students for mutual benefit, because everyone learns from everyone else. Moreover, cognition goes beyond the individual mind and is distributed across the group, algorithms, software, and the virtual environment.

The virtual institution is thus transformed into a symbiotic cognitive system, as an infrastructure in which people and technologies share as integrated and shared gears, through collaborative processes at the speed of thought. This interaction achieves a better distribution of cognition through cognitive neurocomputing and, like the intelligent institution, the virtual classroom constitutes a code space where individual and group actions are determined by intelligent learning artifacts and algorithms. In this cognitive code space, brain-inspired algorithms interact directly with human cognition, leveraging neurocomputational models to extend and optimize students' cognitive abilities.

These cognitive advances originate in ideals such as pattern recognition and conscious awareness and are not simple modeling practices to represent numerical statistics, but products of the challenges to innovate the obtuse cognition inherited from the traditional pedagogical model, to reorganize and optimize the rusty education system. The resulting imaginary is a virtual classroom in which cognitive tutors, learning content, experiences, data, and cognitive assistants coexist and learn, driven by neurocomputational learning algorithms that optimize the cognitive development of students. In these artificial intelligent spaces, the functioning of the brain is modeled with algorithmic computational processes, and, by selecting and applying cognitive algorithms, it is enhanced to achieve intelligent education.

7.4 EMERGING CHALLENGES

The structuring and materialization of the intelligent education program in the classroom and the neuro-pedagogical curricula should reflect all that is known as *neuro-knowledge* [83], that is, the results of related research in disciplines such as neuroscience, neurocomputation, data science, and neuroeducation. The problem is that these disciplines assume and interpret different brain models, thus applying and constructing different measurement methods and theories, while presenting their empirical descriptions of brain functioning. Moreover, many results, achieved in laboratories and not in everyday life, are attributed to the brain capabilities that are reported as *proven facts* [74].

For example, neuroeducation interprets brain processes as computational or algorithmic, because so far it is part of emerging experimentation that tries to reduce neuroscientific discoveries to a simple *strategic political intervention* [84]. In this kind of *bio-politics* of the brain, these discoveries play an important role in the design of *control programs* by governments and corporations in much of the world. This has led to plans to govern or direct human behavior, which becomes a challenge facing the intelligent education program and neuro-cognitive algorithms.

As a result of studies in science and technology, neuroscience is conceptualized only in terms of interpretations, translations, or mediations of bio-political work. What is required is that knowledge of the brain and applications in cognitive computation be considered as *social practices* oriented to design a neurocomputational model base for intelligent education, among many other social and ethically responsible applications. The work in this sense should move these developments away from malicious interventions that seek to condition people's behavior and make them potential the improvement of their education.

In globality, algorithms acquire social power due to their use as organizers of everyday life, with extensions towards individual and group intervention through human-computer interaction and using algorithmic directionality. This has to be part of the discussions about cognitive computing in education, because, when it is intended to condition human subjectivity, the debate about the influence of neuroscience faces social and ethical challenges; although in such debates one cannot lose sight of the fact that many of the simplistic claims about brain manipulation are only attempts to position strategic plans to demoralize neuroscientists and turn them into mere political-commercial actors.

An example of this is the notion of neuroplasticity of the brain, a key concept in neuroscience. For some, the malleability of the brain makes it open to all kinds of contributions, and, through training and strengthening of synaptic connections, it is possible to intervene in its neuronal architecture and functional organization. As a result, an emerging field has been created that attempts to develop neurobiological mechanisms aimed at encoding aspects of people's social life in the brain

[85]. These ideas quickly became support for the idealization of techniques which is intended to reconfigure and re-model the brain structure, to satisfy some kind of bio-political demand. Although the imaginary of brain plasticity generated an instance of intersection between the social and the neurobiological, it is used to develop policies and practices in various social dimensions that exceed ethical responsibilities.

The intelligent education program is a way to take advantage of this and other discoveries and developments in neuroscience, neurocomputing, and computer science in a socially responsible way. In the proposal of the virtual classroom, as an environment in which tutors, counselors, and students coexist, the imaginary of the malleable brain can be used as a feature to enhance learning.

Intelligent algorithmic models allow the construction of cognitive systems that emulate the plasticity and neural networks of the brain, offering a space to put into practice revolutionary teaching and didactic models, which virtual teachers materialize with the idea of reconnecting the neurological circuits on which students' learning is based. This environment is covered with ethical and moral responsibility, because the objective is to educate students intelligently and, although the mediation is done by Information Technologies, those in charge of supervision, design, and implementation are people.

The intelligent education program achieves a conjunction between technological developments and the knowledge of the brain that science has achieved. Although due to previous experiences and the undue manipulation that governments and corporations have given to these developments, many might doubt the morality of the program. This sociological and ethical debate about the *social life of the brain* is hot from every point of view because science seems to show that everything in it can be re-shaped neuro-scientifically. In this sense it is necessary to examine how knowledge of the brain can imply a change in the understanding of human subjectivity; moreover, it seems that human development occurs through *epigenetic* changes, which are initiated in the environment and transmitted through a kind of programming, and not as it was thought from genetic inheritance [86].

These statements serve as support to initiate a scientific revolution in which it is assumed that humans and technologies co-evolve *technologically* because technological developments are integrated into practically all human activities, to the point that in this century it is not possible to speak of human progress without involving the omnipresence of computers, microprocessors, and intelligent algorithms. Therefore, in this co-evolution, there must be a particular integration of neurology.

On the other hand, *unconscious cognitive systems* have also emerged and increasingly permeate technology, so in many cases, it could be said that *cognitive processes* are also carried out in machines, which undermines the traditional belief that they can only occur in the mental world of humans [87].

This non-anthropocentric view of ubiquitous cognition proposes that some devices, considered cognitively unaware, develop autonomous learning processes, modeled after biological organisms, as well as take advantage of their experiences to deploy skills that allow them to interact with each other and with humans. It is expected that, if they ever penetrate human systems, they could modify their behavioral dynamics, because they would techno-genetically alter the configuration and functioning of the brain [88].

Although at some later point, this scenario may materialize, the models that are developed in the intelligent education program to take advantage of the imaginary of neural plasticity, and that emerge from neurocomputational and neuroscientific discoveries, are only used to create intelligent and unconscious learning algorithms for cognitive computing. Subsequently, these algorithms are responsible for structuring, activating, and directing, with human supervision, the intelligent virtual classroom environment, as a space for students to improve their cognitive capacity by interacting with peers, tutors, and advisors, but also with *unconscious cognitive agents*.

In other words, for the imaginaries of intelligent institutions and cognitive computing, the goal is to re-evolve the rusty education system by transforming methodologies, didactics, verification and validation processes, and learning outcomes. Thus, the functioning of the brain is translated into intelligent algorithms to develop cognitive computational models, which are then used in the intelligent virtual classroom space to improve the teaching-learning processes. The ethical and collaborative work of virtual and human tutors and advisors is a process in which part of the functions of the educational environment is delegated to intelligent algorithms, which direct the functioning of the cognitively unconscious devices on which the structure of the virtual classroom is based.

In this imaginary, the student resembles a moldable brain, understood in terms of computational algorithms, which coexists in other extracurricular environments that infer a large part of their learning. In the intelligent education program, the school space develops a specific form of neurocomputational knowledge, but the other spaces in which the student coexists contribute social, cultural, and experiential knowledge, which becomes a symbiotic cognitive system where algorithmic models of cognition and unconscious learning are combined with conscious human models so that the student achieves the learning results.

With this vision of intelligent education, a hybrid between programmable spaces and neuroscientists in the virtual classroom materializes, to develop the notion of brain-code-neurocomputational space. This is the basis for the development of intelligent virtual institutions and classrooms, where learning algorithms, data science, and cognitive computing come together to offer real intelligent education. This generality is possible because the intelligent virtual classroom spaces are built from automatic brain models that, from intelligent algorithms, encode the individual functioning of the students' brains and insert them as learning spaces in the virtual classroom.

This cognitive infrastructure incorporates the developments and discoveries of neuroscience, such as brain plasticity, and of neurocomputing, such as intelligent algorithms, to direct the functioning of the virtual environment with human supervision. In any case, any process that is structured and applied in these environments will have merely cognitive objectives, without any relation to what is intended from the bio-political scenarios, in the sense of wanting to convert the human body into molecular software that can be read and rewritten [89].

In other words, the brain-code-space notion is a novel principle to convert brain functions into data and encode them by unconscious intelligent algorithms, and then design and develop applications to improve human cognition. This environment represents a connection between projected neurological knowledge based on technical expertise accumulated from learning algorithms, neural networks, cognitive computing, and neurosynaptic modeling. This is possible because science has shown that: 1) it is possible to understand and model the learning brain, 2) it is possible to understand it computationally, 3) its synaptic connections and neural pathways can be modeled, and 4) this functioning can be encoded in intelligent algorithms.

This chapter describes some substantial components to materialize the necessary revolution to the education system, which makes up a basic presentation of the intelligent education program, which aims to create a hybrid educational model between the developments and discoveries of neuroscience, neurocomputation, neurocognition, and Computer Science. It is a bet to revolutionize the rusty education system through imaginaries such as the intelligent virtual institution and the intelligent virtual classroom, conceived as cognitive learning environments in which intelligent algorithms and unconscious cognitive applications are merged with the intra and extracurricular experiences and experiences of students, to model learning in a brain that learns.

Intelligent education is developed in neuro-social school spaces, where learning is achieved through practices modeled on the neuro-scientific and neuro-computational understanding of students. The intelligent virtual institution is an imaginary brain-code-neurocomputational space and the intelligent virtual classroom is a cognitively designed environment, where students coexist with digital tutors and counselors, advised by human teachers, with a single goal: to *develop their cognitive capacity*.

These imaginaries are learning environments in which scientific knowledge of the brain is diagrammed as spatial maps to model cognitive processes, and where the educational process is based on learning algorithms, built from the knowledge that science has accumulated and projects to find out about brain functions.

Another issue described in the text is that unconscious computer brains have already been integrated into the environment shared by humans and machines. Of course, much of this development has not been natural, because some governments and corporations are interested in taking advantage of the malleability of the brain to refocus its functioning for their benefit. That is why the basis of the intelligent education program is a reimagining of the human being in terms of the accumulated knowledge about how the brain works.

Intelligent education is understood as an educational revolution aimed at innovating the way people are formed and how professionals are trained in this century because it represents a substantial change in how human beings are conceived, constituted, configured, and administered in the traditional education system.

The dream of the program is not to diagram the brain but to model and build intelligent algorithms that materialize in applications inspired by it, with the idea of transforming the conception of the human learning subject. To achieve this, human cognition and computational cognition must be conceived as analogous, that is, as intelligent algorithmic systems to monitor, review, reconnect and optimize learning at all times.

This description intends to generate research processes that deepen the empirical search for practices to materialize the intelligent education program, taking advantage of transdisciplinary knowledge, techniques, and applications achieved from neuroscience, neurocomputation, neurocognition, and Computer Science. For example, from neurocomputing, the challenge is to trace the systematization of the brain as a complex neural network and design applications that help to improve the understanding of its morphology, as well as its cognitive functioning, to build algorithms that learn in the same way. In this order of ideas, it is necessary to learn to design intelligent cognitive algorithms that model the plasticity of the learning brain.

The design and construction of the intelligent virtual classroom is an instantiation of algorithmic practices developed in research on machine learning and cognitive computing. In such a case, the imaginary of the intelligent virtual institution, as a technological project, is based on the knowledge of the particular socio-technical and social scenarios of the students, projected to be useful in later moments of intelligent education. In this way, the institution materializes as a natural cognitive environment, where students are conceived computationally, as well as people in terms of their existence, neurobiological malleability, and ability to learn from natural and artificial contexts.

In these environments, machine learning algorithms and other neurocomputational techniques are designed and built to model a cognitive process that integrates the social environments of people, considered cognitive agents. In the virtual teaching-learning environment, the brain is seen as an organ that learns and interacts socially, but whose learning can be enhanced using intelligent learning algorithms and modeling devices.

Due to the bad practices of the so-called bio-politics, the improper use of a process such as intelligent education could bring harmful consequences outside the institution, because pretending to automate it without human supervision could make the algorithms learn beyond the purpose for which they were created, to the point of not differentiating between people and machines. The point is that while the machine can be *programmed* with fixed code, the *person* will remain a natural cognitive being, whose brain cannot be *programmed on purpose* without analyzing the effects generated by each algorithm.

This may generate imaginary neuro-futures in which it is assumed that the brain can be fully understood, mapped, visualized, maintained, managed, improved, or optimized or, as some science fiction authors presume, designed and built. What is at stake here is to help human beings to develop or enhance their cognitive capacity, and to put learning at the service of society.

The hybridization of knowledge from neuroscience, neurocomputation, and computer science generates new computational techniques and practices, which help to materialize the imaginary of the intelligent institution and the intelligent virtual classroom to impart intelligent learning. But the intelligent education program cannot be understood as a kind of *neuro-future for education*, but as a *reality to* be reached to revolutionize the education system.

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8. CONCLUSIONS

The traditional education system considers students as *one-size-fits-all* because it cannot meet the individual needs, expectations, and capabilities of the new category of students. This does not go unnoticed in the research on education in the New Era, whose results are oriented to revolutionize the system and establish a personalized and student-centered educational approach to form people and train professionals. In addition to this, some technological developments and innovations generate tools that can be adapted to the individual characteristics of people, and which are proposed in this book as the basis for designing and implementing virtual teaching-learning environments.

The goal is to personalize education based on the success of new technologies, virtuality, and virtual worlds to meet the specific learning needs, learning habits, and learning capabilities of the new category of students, and guide them in achieving useful learning outcomes in the New World Order. In this way, we seek to reformulate the role of teachers and teaching-learning environments so that students live an enriching learning experience.

Because the goal of education should be to foster students' skills, abilities, and capabilities, and provide them with a holistic learning experience. That is why this paper proposes that in virtual teaching-learning environments, the teacher needs to structure a teaching model to *teach according to* individual capabilities, and not as it currently works under the paradigm that all students are equal.

As the reader has noted in the pages of this book, the call is for *personalized education through* a nuanced teaching model. In the New Age, personalized education involves re-knowing students and, prospectively, predicting their performance and analyzing learning profiles and retention patterns, to provide them with an education that optimizes their learning. In other words, the idea is to improve diagnosis, prediction, treatment, and achievement of learning outcomes, thus avoiding learning losses in the formative process.

In the last decade, research in education, neurocognition, and neurocomputing, together with developments in educational technology, have explored different ways of incorporating new technologies and theories into education. The distinctive and individual characteristics of human beings require the educational system to refocus its attention on the specific learning requirements of students. This means that instead of *all students* having to conform to a 19^{th}-century curriculum and teaching model, the institution and the teacher are obliged to structure a curriculum, teaching model, and content to fit the learning requirements, learning capabilities, and learning outcomes of each student for the New Age.

A teaching-learning environment structured from new technologies works as a system in a *predictive diagnostic* framework, which allows institutions and teachers to prevent learning difficulties and causes in students. In this way, learning is personalized, providing a platform for sharing didactic resources that change the paradigm of education, and developing an interactive, attractive, and motivating system. This is achieved because the virtual system is an automated platform for teaching management, making the teacher's work more efficient and accurate. Using the characteristics of new technologies and the developments of neurocognition and neurocomputing in the virtual environment, students develop knowledge intuitively, learning in a relaxed way and stimulating their desire to learn.

The virtual teaching-learning environment is a different way of looking at and analyzing education and a solution to the difficulties of the educational system worldwide. In many countries, it helps to integrate limited educational resources, communicates the various forms of education and types of school management, improves the use of quality resources, and allows teachers to be trained and efficient in achieving learning outcomes.

This scenario opens a space for the massification of education and the exchange of didactic resources, because its offer is wide, varied, and fast, favoring the rupture of the space-time barrier so that students can learn not only in the virtual classroom but also ubiquitously. On the other hand, it facilitates communication between the various actors in the educational system, because it is a teaching management tool that plays a positive role in the achievement of learning outcomes.

Virtual teaching-learning environments drive institutions to migrate their model from the current learning management system to an intelligent virtual educational system, taking advantage of student data by recognizing them as learning agents. These environments are designed with a different educational perspective, taking advantage of the analytical functions provided by new technologies. In these intelligent virtual educational systems, the teaching-learning process is focused on the new forms of interaction of the New Age oriented to personalized teaching and new processes of evaluation and achievement of learning results.

Likewise, these environments adapt data collection methods and intelligent algorithms in the teaching processes, to find patterns or useful knowledge that the teacher integrates into the contents and in the teaching model. The drone teacher works with innovative forms of monitoring to improve the intelligent tracking of each student's progress, focusing its activity on the students and implementing new ways to validate and verify learning, offering them the possibility of self-assessment, assessing the available resources and working collaboratively with peers without the teacher's intervention.

The intelligent virtual teaching-learning environment offers institutions the possibility of focusing the teaching-learning process on new forms of interaction between the actors. In addition, it helps teachers to select the best technological tools and educational resources to adapt them to personalized education, so that students and teachers live advanced learning experiences. The reason is that the virtual environment is a knowledge-based system because it analyzes and evaluates the environment in which learning is generated and adapts to the individual needs of the student.

The degree to which New Age students benefit from this technology depends on the educational environment in which they discover and create knowledge and, because the teacher plays the role of supplementary instructor, they delve deeper into the content and review the concepts covered in the learning process at the time and place of their choice. In this way, governments will be able to guarantee equal access to education, new technologies, and the use of the Internet, but in a ubiquitous way to all citizens, which will help to create an educated society for the New World Order.

Another context in which virtual teaching-learning environments are widely used is related to employee retraining because it allows them to access knowledge and new techniques for job performance, job training, and career advancement. Companies need employees to learn advanced techniques that help them improve their job performance, and they can organize their schedules in intelligent virtual teaching-learning environments to achieve this because the

ubiquity of their design is free of time zones or physical classrooms. In virtual environments, people with diverse needs and requirements are equally considered and offered innovative opportunities in education. It is a technologically intelligent solution, sensitive to human needs and student-centered, thus expanding access to education without physical restrictions or handicapping conditions.

This book presents an innovative approach to the development of intelligent virtual teaching-learning environments that institutions can use to advance their desire to offer quality virtual education. It also promotes the need to leverage new technologies that serve to enable people to receive unrestricted education for the New Age. It presents an innovative solution in education that places students at the center of learning change the role of teachers and calls for a revolution in the education system. For this approach to succeed, emphasis is placed on the need for institutions to adopt a multidimensional and transdisciplinary vision in the virtual education model.

The content of this book is addressed to educational researchers, academics, industry, educational administrations, governments, teachers, students, and society at large, and invites them to delve into the issues, theories, principles, technologies, and practical experiences related to virtual education and intelligent education. The author intends to sensitize them to the need to revolutionize the rusty education system, to promote the good practices found, to share and evaluate personal experiences and lessons learned, and to work together to train the people and empower the professionals needed in the New Age.

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Virtual Teaching-learning Environment

This book presents an innovative approach to the development of intelligent virtual teaching-learning environments that institutions can use to advance their desire to offer quality virtual education. It also promotes the need to leverage new technologies that serve to enable people to receive unrestricted education for the New Age. It presents an innovative solution in education that places students at the center of learning change the role of teachers and calls for a revolution in the education system. For this approach to succeed, emphasis is placed on the need for institutions to adopt a multidimensional and transdisciplinary vision in the virtual education model. The content of this book is addressed to educational researchers, academics, industry, educational administrations, governments, teachers, students, and society at large, and invites them to delve into the issues, theories, principles, technologies, and practical experiences related to virtual education and intelligent education. The author intends to sensitize them to the need to revolutionize the rusty education system, to promote the good practices found, to share and evaluate personal experiences and lessons learned, and to work together to train the people and empower the professionals needed in the New Age.