Strategies for inclusive and safe education using virtual reality: from the digital library perspective

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Abstract

Purpose – This paper aims to propose the development of formal (scientific content) and informal (content for science communication) educational activities in an inclusive and safe way, involving two essential elements, virtual reality (VR) and the digital library; as well as the implications for its enforcement such as educational strategies in the university setting and for the encouragement of scientific culture in society.

Design/methodology/approach – For the integration of content, a simplified conceptual model was designed first, in which universities and research centers are seen as complex systems where different subsystems, from which processes and information resources are derived, converge. To cover the model’s elements, a descriptive documentary review was developed, looking to synthesize each element’s context and implications.

Findings – The need to establish transdisciplinary relationships between the VR and the digital library is determined with the goal to integrate educational activities using technology, with the purpose of studying contents from the scientific point of view, as well as with the possibility of transforming them into contexts of general access for society, with the objective of social appropriation of knowledge, citizen science and social innovation. In the conclusion section, some implications in the implementation of this type of initiatives are presented.

Originality/value – The aspects that set this paper apart are: treating VR as emerging documents tending to measure their direct impact, not as isolated elements of a collection; identifying the digital library’s social influence actions through VR; and generating processes to encourage the creation of contents with a differentiated focus according to the population served.

Keywords Virtual reality, Digital library, Experimental learning, First-person learning, Social appropriation of knowledge, Immersive technologies

Paper type Viewpoint

Introduction

The new role of universities in their quest for innovation should not circumscribe just to the creation of science-related research or experimentation processes in laboratories to create new products. This way of innovation is limited when the varied dimensions of the changes higher education institutions can experience are forgotten; based mainly on social, cultural and economic realities where there is already a demand to generate heterogeneous services (Sancho-Gil et al., 2018).

The changes in universities not only have an impact on their infrastructure but also the need for variation in the vision of its actors (professors, librarians and students). The main manifestation of the changes does not refer to teaching only, but to multiple learning opportunities where traditional schemes of classroom-related spaces are broken, substituted by technology-based environments (video games, online learning, Web communities, etc.), all represented as separate workspaces (Collis and Halverson, 2018).
The new roles that the new vision of universities demand are characterized by the following:

- The professor must be aware of social and economic reality, show adaptation to accelerated changes, accept that new technologies generate different products and processes and, furthermore, know how to find the human side of technology (Graham and Trevor, 2014).

- The librarian should develop a contemporary vision of technology as a means to share with society, influencing students in their appreciation, value and limitations within society, for decision-making, meaning and critical thinking, and at the same time that it is understood how knowledge is created, evaluated and transformed within scientific areas. The librarian should also promote the abilities to evaluate ideas, processes, experiences and objects in meaningful contexts, influencing long-term learning, knowledge of one’s own learning needs and abilities for knowledge access (Patel and Bhavsar, 2012).

- The student must meet the professors’ and librarians’ demands, practicing self-learning abilities with the information stored in digital platforms.

About academic libraries in universities and research centers, these have been a representative element, both as entities tasked with the protection of the history of knowledge and as a way to measure fundamental recognition indicators of the quality of higher education institutions. These entities share two behavioral patterns:

1. They are not recognized by themselves, only when referring to the institutions to which they belong; therefore, their biggest long-term influence is their predominance in research and learning activities.

2. There is a difference between those that support research and function through evolution cycles by supporting elite research groups with finished products and those that support learning and help students to acquire solid foundations of knowledge by providing ample information resources, without showing concrete evidence in the form of tangible products (Dempsey and Constance, 2018).

For both research and learning objectives, the university library can maintain a pattern of organizational behavior related to the institution it belongs to. Beyond that, it can add new services, as it has happened with the generation of digital libraries, which take both dependent and functional roles of academic libraries, just as they are from the universities they belong to. In this case, the digital library can be seen as a part of a large system or, as an independent system, because it is composed of a set of interrelated elements (concepts, objects and people), a whole made up of interrelated parts (Torres-Vargas, 2008).

This article proposes the digital library working as something beyond than a mere repository (in general terms, a place where open-access documents are stored), and also as an educational proposal of innovative services, incorporating virtual reality (VR) to influence both formal (through the provision of scientific content resources) and informal educational processes (through generating resources and services with a social focus for the general public). Under this perspective, digital libraries and VR are positioned as two key elements within a systemic work model (Figure 1).

**Virtual reality as an emerging digital document in educational technology**

VR contents must be treated in the same manner as any document handled in a traditional or virtual library. VR content is composed of still photographs and videos of places, things or real events. The three-dimensional (3D) image is merged into one file with 360° vision...
through technology. Furthermore, voiceover, music or auditive ambiance can be added if chosen to.

The integration of this type of content should be based on the consultation of scientific sources, and the way of expressing them will depend on its purposes and the target audience. Special VR goggles are necessary to access its content; the different ways of use do not matter (online or stored in a cellphone memory card, laptop or desktop computer).

The production of VR documents is done through a camera with at least two lenses in one simple device, but not with the available alternatives such as 16-lens cameras or 34-lens devices (used in the film industry). Content can be edited in each camera’s included software.

When VR contents are stored on a website, it is necessary to install a plug-in to allow the user to access files without the need to install additional software on their personal computer. If VR contents are stored in personal computers, laptops or cellphones, they will take up plenty of storage space. In this case, to see images from computers without internet access, it is necessary to install firmware that will allow for the content to be seen. Big companies such as Google, Twitter, Facebook and YouTube have plug-ins that allow their users to access online content without having to modify their devices.

In all cases, the only way to access VR contents, which cannot be published on paper, is digital, non-conventional documents that demand technology as a middleman. When the document is online, it is possible to see from any smartphone and universal VR goggles compatible with any cellphone; however, a few others are specific to each brand and present a variation in quality, resolution or content definition which can be high or low. There are computer goggles as well without the need for a cellphone, these have some advantages against the cellphone ones because of the number of informational resources that these applications demand.

Both VR documents and other immersive contents regarding places, things or real-life events that are produced with VR (such as mixed VR) may also contain some additional non-real elements to expand information, having the possibility to become interactive, wherein the audience can participate and manipulate objects within the content through sensor gloves. These types of documents are known as mixed reality because they combine the real place or object with the imaginary one that helps to explain something. Augmented reality, which is stored and seen in the same way as traditional VR, is the third immersive technology, but this one has animated images and regularly used for entertainment, videogames or movies with a script and previous production, similar to the regular cinema but in 3D and 360°.

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**Figure 1.**
A systemic model of VR and digital library inclusion in education
Education, digital library and virtual reality: toward a transdisciplinary focus
This paper’s focus is on the need for transdisciplinary knowledge, which, from the functional perspective, includes educational settings, libraries, laboratories and technology (in this case, VR). From the cognitive perspective, transdisciplinarity intends to integrate the culture through necessary knowledge, such as critical culture, relevant knowledge, teachings of all sciences (from the physical, biological and sociocultural perspective) and ways to face uncertainty, such as the comprehension and ethics of being human (Pupo, 2013).

The universities and research centers’ functional and cognitive activities have stopped operating as isolated bodies. Mediation processes between the traditional and the technological pose a key aspect to know the real role that electronic media plays in education, which represents an opportunity to improve along with transformation of culture (De-Pablos-Pons, 2018). Stemming from the aforementioned ideas, the academic world has taken steps to streamline contents through recommendation systems that evaluate and filter certain available information to help users in learning processes (Tejeda-Lorente et al., 2014). The universities have also generated repositories to provide users with a set of contents by areas of interest (Hienert et al., 2015).

The relationship between education and the university library is associated with the provision of printed documents, while that interaction does not happen between education and the digital library because of the search of documents with plain content (text), but not images. Such paradigms must be broken, and the great diversity of the formats information presented in Valtierra-Lacalle (2018) must be considered and included in the content of libraries; among these, VR with immersive experiences that augment comprehension with explanatory purposes, by portraying sites, things or situations, stands out (Massis, 2015). VR has progressed so much, to the degree of generating content in these types of truly significant and productive formats, with the possibilities to prove its effects directly (Sherman and Craig, 2018).

Even when there is a strong association of VR with issues relating to recreational aspects or cultural promotion, there are platforms that have explored the visualization of scientific data, using immersion with the goal to improve perception, comprehension and retention of contents, unlike when one can only access to written data (Donalek et al., 2014). Digital technologies observe such a condition of transdisciplinarity so that they can influence in such basic educational aspects, where knowledge is sought after as a stimulus of creativity in disciplines where there is still illiteracy (Serna, 2016), even the interest of academic sectors in the resolution of complex problems of science and society (Klein, 2015, p. 11).

Applying virtual reality in formal education programs
Today’s formal education has been influenced in two fundamental ways in its relationship with technologies:

(1) directly, used to solve concrete academic issues such as text and data processing, architectural or engineering artistic graphic designs, etc.

(2) indirectly, when subjects access electronic media on their own accord: games, video broadcasts, the sharing of ephemeral images and messages, etc., all of this distinguished as the Age of Experience, where technological equipment is used on a daily basis to share and experience perspectives (Hu-Au and Lee, 2017).

Considering today’s university students’ characteristics and the purposes of joining formal education (as a transmitter of scientific knowledge) with the digital library (a space of administration and safekeeping of digital documents), the relevant proposal of including the creation of documents that contribute to the access to scientific information in a formal way, its characteristics should resemble the demands of the previously mentioned Age of Experience, it is without a doubt the provision of VR documents.
The use of VR in education offers a bigger interest beyond just learning; it contributes to student development in different ways, such as academic performance and motivation, social and collaborative skills and cognitive and psychomotor skills (Martín-Gutiérrez et al., 2017). From the academic perspective, it is proposed to change the traditional teaching methods, generate learning from a constructivist perspective, identify the relevant learning contexts, influence in the students’ identity, offer more than just classrooms as educational spaces, the possibility to identify difficulties in models and to get to know new knowledge perspectives (Curcio et al., 2016; Hu-Au and Lee, 2017).

The formal applications of VR in education with digital library support can be classified into following types:

- Safe education in risk situations or scenarios, such as the case of mining, the construction industry (Grabowski and Jankowski, 2015) or incidents caused by nature or by accident (Williams-Bell et al., 2015).
- Protected settings for preservation and conservation purposes, which are sometimes far from the students’ environment. Applies in architecture, archeology (Delgado-Anés and Romero-Pellitero, 2017) and art (Serafin et al., 2016).
- Scientific subjects that, because of their condition of abstraction, are not observable with the naked eye, such as the case of some chemical processes (Saritas, 2015; Chao et al., 2016; Winkelman et al., 2017) or biology-related aspects (Weng et al., 2016).
- Identification of scientific vocations through the use of situations of a profession that place the student in a certain reality, and this way, decisions are made with regard to the likes or dislikes toward certain activities (Pérez-González et al., 2016; Villalustre-Martín and Del-Moral-Pérez, 2017).
- Attention to situations or models that demand prior and sufficient practical experience before developing a real activity, identifying design or application errors. This kind of situations is regularly associated with medicine, construction and hazardous material design, among others (Hsiu-Mei et al., 2016).

It is essential to recognize that information users from higher level formal education fields are characterized by the search and use of quality documents; therefore, VR documents with similar purposes of education should have the same conditions. With regard to the search for scientific information, regularly, quality is determined by the source that publishes the content, being the most concrete form those journals belonging to databases of recognized quality (e.g. Scopus and Web of Science), where the use of adequate scientific language is expected, although beyond this, the collected data show precision, integrity, consistency, validity, opportunity and accessibility (Laudon and Laudon, 2012; Alshikhi and Abdullah, 2018); with regard to the use of scientific information, it is characterized by showing patterns of behavior that start with the goal to satisfy a need for information and to define the processes of a precise search in which the following are considered: connection with existing knowledge, selection of precise information, exploration of documents to decrease uncertainty, trust acquisition, relevant information recollection and presentation and integration of results (Baro et al., 2010).

Virtual reality and the digital library in social knowledge appropriation, social innovation and citizen science

Since the arrival of the internet and the massification of computers and smartphones, the knowledge previously available only to those getting college education was made available to general society. Today, information is available to everyone; from this, two matters arise:
(1) the difference of the levels of quality in information from citizens; and
(2) the definition of effective communication channels between scientific communities and society. Both situations determine ways of generating scientific culture.

The excess of communication channels that are available for any citizen (especially those unfamiliar with academic settings) generates a cognitive dissonance (an excess of simultaneous communication channels) and, by consequence, causes major difficulties in differentiating between levels of information quality. While democratization of knowledge is being sought, there is a high risk on the citizen becoming involved in post-truth actions (when one accepts contents that offer both false and true data as valid, regularly linked to pseudoscience or false science), achieving to provoke the consideration of post-normal science as a source of consultation, defined by Peters and Besley (2019) as information characterized by incomplete, uncertain or questioned knowledge for decision-making purposes, a condition leading to a critical reflection on how such characteristics affect the relationship between science and governance.

To avoid the use of inconvenient information, scientific culture in citizens becomes necessary because of the following reasons:

- practical (knowledge of science and technology for everyday life);
- cultural (profound influence of individual’s worldview and environment);
- economic (scientifically alphabetized workforce); and
- democratic (informed social participation, where the citizen learns to make policies mediated by technology) (Marín-Agudelo, 2012; Doménech-Casal, 2018).

That is how the so-called scientific citizens are born, those who are capable of generating citizen science, where citizens participate in finding the solution for problems addressed with scientific rigor (Dennhardt et al., 2017).

On the contrary, given the lack of a scientific culture, the common citizen tends to accept information from different perspectives, characterized by the following patterns: considering as true anything that is published without verifying data, lack of critical judgment to distinguish quality information from what is not, making decisions based on false information without comparing and crediting sources and authors, taking rumors as facts, experiencing distressing processes as a result of misinformation and overinformation (Morales-Campos, 2018; Mireles-Cárdenas, 2018). This issue is intensified because citizens see difficulty when trying to identify reliable information, and the scientific evidence of informative disorders brought by post-truth (Del-Fresno-Garcia, 2019). The most viable solution is the structure of documents in assimilable conditions to the citizens who generally do not read or analyze the content; however, it is usually perceptive through the image.

Recent recommendations for knowledge sharing between scientists and society include:

- The participation of a VR documents co-creator, who is a specialist in communicating scientific messages, with an adequate interdisciplinary dialogue coordination (Atuesta-Venegas et al., 2016; Senabre et al., 2018);
- The creation of mechanisms against knowledge concealment, avoiding all linguistic barriers between scientists and society (Elías, 2002) with the goal of producing changes in both participants (Burningham et al., 2007); and
- Seek to achieve social appropriation of knowledge and a more ambitious objective called “citizen science,” where general society participates actively in the scientific production of knowledge (Bautista-Puig et al., 2019).
Museums are among the most traditional initiatives to bring knowledge to society and influence citizen science, where VR can be used to increase understanding and intellectual curiosity levels (Valtierra-Lacalle, 2018). For example, a recent experience for knowledge-sharing is known as “first-person experience” where cultural heritage, marketing, knowledge and entertainment management are merged; here there is a three-part participation: the artist creates content, the institutions disseminate it and technology makes it available (Izzo, 2017).

VR is an innovation in the way of presenting content and the impact on user diversity it may have, because it is an inclusion tool with regard to transmitting information to people who, because of reasons of health, age, finances or distance, would not, otherwise, be able to access sites of historical, archeological or natural importance; it is also regularly for the citizens who do not develop formal education activities inside a classroom (Delgado-Anés and Romero-Pellitero, 2017; Joo-Nagata et al., 2017).

This type of initiatives generates documents both for formal and informal education, with curricular and extracurricular interventions; it designs hybrid, flexible and creative learning contexts (Melgar et al., 2018), its approach offers elements of inclusive education that work in special education, where people with mental and physical deficits and those of advanced age are considered (Nachimuthu and Vijayakumari, 2009), participants gain greater autonomy in daily life and relationships with other people become easier (Bhagat et al., 2016; Martin-Sabarís and Scaringi, 2017). It should be taken into account that the information specified in VR for citizens must necessarily come from scientific information. The social impact must be measured through results from these three concatenated conditions:

1. **Social appropriation of knowledge.** This concept is broad in definition, starting with the synonyms used in scientific literature, such as knowledge appropriation, technology and innovation; public communication of science and technology; and popularization of science and technology (Escobar and García, 2013), and it is even considered that the initial concept was scientific dissemination. In all cases, there is a strong association with technology and innovation as a means of generating scientific culture, searching for mechanisms by which scientific communities integrate, spread and protect knowledge with (Kamoche et al., 2014).

2. **Citizen science.** It consists of the development of scientific research carried out in collaborative, cooperative and co-created projects between scientific communities (which assume the ethical part of the project) and citizens (regularly with voluntary participation) for purposes of systematic data recollection and analysis, development and understanding of new knowledge and technology, phenomena tests, sharing of best practices and dissemination of research results, all based on genuine achievements (Robinson et al., 2018). The result of these activities allows for the interaction of science–society–research policies toward processes of science democratization based on informed participation (European Commission, 2014).

3. **Social innovation.** Original and practical ways that contribute to improving the relevant social issues. Beyond mere appropriation, it includes the collective application of scientific knowledge in projects or organizations aiming to facilitate the search and development of alternatives to social order issues, to improve quality of life and diminish the vulnerability of communities (European Commission, 2017). It includes products, services and models, both newly created and redesigns of existing ones, which satisfy social needs and ways of collaboration. They are, in general, economically sustainable and, eventually, socially responsible companies arise from them.
Conclusion

VR through the digital library can have a broad impact, both in formal and informal education, by bringing knowledge to a larger number of people and contributing to the economy of education. Its implementation should not be limited to the simple incorporation of this type of documents to virtual archives, but to work in a systematic and planned way in their use, and in search for applications to achieve results, in controlled groups and not by users who access the documents by chance.

Although VR offers multiple advantages, it has the following implications:

- The development of its materials is expensive, both in technological equipment and in the creation of content with a focus for different audiences.
- The complexity in the involvement of faculty, researchers and librarians in a coordinated way represents a challenge in the face of adding bigger workloads; and
- The social influence through these media is an activity with almost zero exploration, with little possibilities of influencing an incipient scientific culture in society in general, and sometimes in school settings.

Considering that content production using VR becomes one of the most critical elements, it is proposed to turn to social innovation projects as a sustainable service, which involves: (i) the professor-researcher (who provides scientific content with a didactic methodology); (ii) the work of a content producer, editor and designer, endorsed by the professor-researcher; and (iii) the digital library that stores and makes the documents in its digital platform available for users.

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