Say It, Do It, Learn It! Digital Education at the Museum: A Theoretical Reflection Towards a Review of the Studies on the Application of Digital Technologies in Museum Education

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ABSTRACT: *The museum has always been an educational space at the forefront of change. Since 2000, museums and galleries have gradually integrated the digital experience into the overall museum experience. Today's museums do not communicate in the digital space but do exist in it by experimenting with new forms of cultural inter-understanding, while still respecting the different expectations and skills of its public. How does the interaction between virtual and physical spaces help or hinder learning? Does the interaction between physical and virtual realities require the construction of physical learning spaces to consider the modulization connected to the virtual world? Focusing on the theme of how virtual environments can act as effectors or substitutes for our physical learning environments, this contribution, starting from a theoretical reflection to describe educational digital contexts as spaces for virtual social learning, proposes a review of some international studies on the use of digital technologies in education, starting from the museum. Among all different theories of learning, connectivism and activity theory suggest that our digital tools and the socio-historical culture that surrounds the public become an intrinsic part of the learning process. It is interesting to consider how these same processes apply to both virtual and physical worlds, since virtual worlds and physical worlds are not mutually exclusive entities but intertwined in parallel realities that not only influence each other but also each individual within them. Many researchers note that, nowadays, museums are placing a never before seen emphasis on education by highlighting that museums should be included in virtual learning environments, where they will be able to explore the use of digital technologies to interact with visitors in public environments, respecting the museum's mission to transmit knowledge of cultural heritage. This new attention placed by museums to the digital is also to attribute to the change introduced by the International Council of Museums (ICOM) regarding the museum's mission, that is the transition from a museum conceived almost solely for conservation to a user-centered museum (ICOM, 2007, museum definition, 1).*

KEYWORDS: museum education, experiential learning, digital museum.

Introduction

The goal of this article is to propose a critical review of the international scientific literature on the subject of digital museum education. Starting from the presentation of some scientific studies, we propose a review of some learning theories useful to describe virtual social spaces and contexts of educational technology, such as: *constructivism, social cognitive theory, connectivism, computer-supported collaborative learning* and *activity theory.*

Methodologically, the selection of scientific articles was carried out according to the following criteria: 1. relevance to the topic of digital education; 2. geographical distribution of the cited studies; 3. chronology of scientific publications, favoring recent research. The criterion of relevance to the topic has oriented the selection towards international research focused on the use of educational paths, proposed by museums, via digital technologies. The criterion of geographical distribution was followed to ensure a broad representativeness of the selected scientific publications. The corpus of publications refers to studies conducted by researchers from various universities in various parts of the world, in order to guarantee the widest scientific, cultural, and technological heterogeneity, with respect to the research and results obtained. The selection of publications according to a chronological criterion made it possible to follow a temporal thread that describes the evolution of the theme and the state of the literature. This approach focuses, in particular, on the studies and research carried out in the last five years.

1. International framework

Since 2000, museums and galleries have gradually integrated digital technologies into the overall museum experience (Mason, 2013). To describe museums after the digital revolution, Parry (2013) introduces the concept of a post-digital museum in which «digital media have become normative within the Institution» (vol. 1, 24-39). In this scenario, museums are pushing the boundaries of the digital revolution beyond the introduction of cutting-edge technologies. Whenever the digital is used, the museum experience becomes an integral part of the visitor's overall experience (Mason, 2013). The tendency to adopt interactive and multimedia dissemination methods makes the contemporary museum assume the hybrid connotation of exhibition space and classroom (Carci et al., 2019). The collaboration between museum, education, and communication, throughout the process of conception, design, and development of digital resources, is what shapes these practices. But, while the technological change of museums is widely documented, research on the impact of technologies on cultural practices and social models in general is still lacking (Evrad, Krebs, 2018).

The four-year V-Must (Virtual Museum Transnational Network, 2011-2015) project, funded by the European Commission and coordinated by the National Research Center (CNR), has done significant work by examining various virtual museum projects in Europe and in non-European countries (Sartini et al., 2015). On the basis of this work, a general framework has been proposed based on the concept of «responsive museum» (Hazan, Hermon, 2015), which sees museums as participatory communication nodes built around collections. This framework has provided some guidelines for implementation— such as interactivity, personal experience, rich content, narratives, and coherent display of exhibitions— but has not investigated the question of the interpretative approach typical of virtual museums, which largely hindered the evaluation of this framework's impact and development (Perry et al., 2017; Carci et al., 2019).

Many researchers note that museums now place a never before seen emphasis on education (Falk, Dierking, 2016; Styliani et al., 2009; Sylaiou et al., 2010), highlighting how museums should be included among virtual learning environments whenever they explore the use of digital technologies to interact with visitors in public environments as a way to live up to their mission to transmit knowledge of cultural heritage (Scavarelli et al., 2020). The new attention to the digital in museums can also be traced back to the change introduced by the International Council of Museums (ICOM) regarding the museum's mission, that is the transition from a museum conceived almost solely for conservation to a user-centered museum (ICOM, 2007).

As summarized by Bitgood (2013) and Witcomb (2015), through the use of digital technologies museums aim to provide meaningful learning experiences for their visitors. Often, however, they still use approaches to learning that Franklin and Papastegiadis (2017), drawing on the work of Hanquinet and Savage (2012), define the most «ancient and culturally paternalistic form of 'educational recreation' that appeals only to a very narrow segment of the educated middle classes» (p. 42). In her recent work, Daniela (2020) notes how none of the virtual museum applications analyzed has been shown to provide the opportunity to build new knowledge or skills using concepts learned only in new virtual contexts. Virtual museums can be considered as learning agents, they can help expand collaboration with digital materiality, help visualize and spatialize abstract concepts, but the material should be prepared by keeping in mind the learning process (Daniela, 2020; Gaylord-Opalewski and O'Leary, 2019; Panciroli and Macauda, 2018). Carci et al. (2019) observe, on the basis of a review of Italian experiences, that the digital can only represent an effective tool if strategies and action plans are defined on the basis of the initial situation of the museum, of the objectives we intend to achieve with technology, and of the informed choices motivated by the available digital solutions, all within a general strategy of audience development. Perry et al. (2017) note that it is increasingly common to see museums seeking diverse and complex outcomes, such as facilitating

change, social activism, creating intellectual and emotional experiences. However, the same authors underline that the research is heterogeneous and weak in terms of evidence and possibility to generalize the results (Perry et al., 2017). Starting from these premises, the *Emotive* project, funded by the European Commission under Horizon 2020, has developed prototypes aimed towards different museum-visit contexts (i.e., site visits versus remote visits; synchronous or asynchronous visits; individual or group experiences), different technological and mobility needs, different multimedia resources and communication priorities.

Indeed, one of the main changes in cultural practices is linked to the great diversification of the ways in which content, information, and social experiences (Stryszowski, 2012; European Commission, 2015; 2018) are accessed; therefore, the true potential of a virtual museum lies in the creation of personalized, immersive, and interactive ways to improve our understanding of the world around us (European Commission, 2015). In this context, the relationship between the real and the virtual is an important and stimulating issue for the future of museums in the digital age (Bertacchini, Morando, 2013) and yet, surprisingly, little academic research has been conducted in this area. Most research addresses the contents and communication strategies of museums' websites or social media (Courtin et al., 2014) or conceptualizes digital tools as possible products and/or new markets. Still lacking is research on the sociology of users and on their attitudes or representations (Evrad, Krebs, 2018).

1.1 Definitions

The terms 'presence' and 'immersion' are sometimes used interchangeably, but most authors accept the following definitions:

- *Immersion*: the technological offer from an objective point of view. The greater the number of technologies that cover the different human sensory modalities, the more immersive the experience (Bowman, McMahan, 2007).
- *Presence*: the element that makes virtual worlds real; it is the point where an individual begins to accept an artificial reality as reality. It includes two main illusions: (1) the illusion of place (illusion that the place where I am now is actually real) and (2) the illusion of plausibility (illusion that what is happening is actually happening) (Slater, 2009). It is necessary to remember the concept of embodiment, which is considered an integral part of learning (Johnson-Glenberg, 2018).
- *Embodiment*: describes the mental representations of the body in space. It can be physical and/or virtual. The three main components of embodiment are (1) properties of the body (the sensation that the inhabited body is one's own), (2) position of the self (being in the place where one's body is) and (3) acting (that is, an individual can move and feel their body) (Borrego et al., 2019). Johnson-Glenberg MC (2018) indicates embodiment and presence as the *«two deep offers of virtual reality»* (Vol. 5; Art. 81; page 2).

Zimmons and Panter (2013) demonstrate that making digital worlds more photorealistic does not necessarily increase presence; Jerald (2015) suggests that full presence is achieved by focusing on the user's physical interactions, body signals, and social communication. In the development of virtual applications, it is necessary to consider: the *fidelity of representation* (how much the images correspond to reality); the *fidelity of the interaction* (how much the interactions correspond to reality); and the *experiential fidelity* (how much the perceived experiences correspond to reality).

2. Learning theories for virtual spaces and digital media

There are several learning theories used to describe the contexts of educational technology. The following theories are useful to represent learning within virtual social educational spaces.

- *Constructivism* is a *learning-centered* theoretical framework that places the learning subject at the center of the educational process. It stands as an alternative to a *teaching-centered* educational approach based on the centrality of the teacher— the only and undisputed holder of a universal knowledge, abstract and independent of any reference context. Constructivism focuses on the centrality of students actively building their knowledge through a more experiential model. Dewey referred to this as «genuine education» and Vygotsky emphasizes that «*this process is a social process mediated through the symbols and language of a culture*» (Merriam, Bierema, 2013; Vygotsky, 1978). Furthermore, constructivism is generally considered to be crucial for self-directed learning (Zimmerman, 1989) and for Lave and Wenger's concept of situated learning, which suggests that the environment helps in-form learning in individuals (Lave, Wenger, 1991; Merriam, Bierema, 2013). One of the best-known experiential learning processes is Kolb's learning cycle, which defines learning in four phases: *«concrete experience, reflective observation, abstract conceptualization, and active experimentation»* (Kolb, 1984).
- *The social cognitive theory* proposed by Bandura considers both social and personal effects on an individual's activity and motivation (Bandura, 1989). Schunk (1996) defines social cognitive theory as learning that occurs within a social environment, through the observation and emulation of others: we learn by observing others and adjusting our efforts based on their reactions. These are essential reflections for any social virtual reality system as they help to better understand how the social context can both help and hinder an individual's learning.
- *Connectivism* is a theory of learning in the digital age that focuses on the idea that all learning takes place in a network, a connection

of entities, not only within the learner's mind but also through external nodes such as «non-human devices» (technological devices and the internet). Connectivism is based on the concept that learning is a *network-forming process*, based on the principles of diversity, autonomy, interactivity, and openness. It promotes a holistic approach that evaluates the widest possible spectrum of knowledge-related points of view. It considers knowledge as the result of an interaction between all the individuals involved in the learning process. Web 2.0, with its democratic, open, and social structure, has greatly contributed to the transformation of learning, making the process active and interactive. The social tools in this environment become places dedicated to the creation of meaning (sensemaking spaces). According to Siemens (2005), the dominant trait of humanity is the acquisition, processing, and creation of information, which improves through social interaction. Although not yet accepted as an independent theory, the number of studies referring to Siemens' concepts in combination with existing learning theories is growing (Bell, 2011).

- *Computer-Supported Collaborative Learning (CSCL)* is more of a teaching strategy than a theory and it is an important aspect in any discussion about the use of virtual reality in social learning spaces, since it deals with how students collaborate using computers (Stahl et al., 2006; Stahl, Hakkarainen, 2020). The importance of CSCL is central both in the reflection on the relationship between student and technology and in the professional development of teachers. Furthermore, it is crucial when considering the effect of the environment on learning and on the socio-cultural or socio-historical contexts of social learning spaces (Stahl, Hakkarainen, 2020). Some CSCL theorists rely on the principles of activity theory, which describes human activity through a lens that considers the individual, the objectives, and the community as interconnected (Engeström, 1987; Stahl, Hakkarainen, 2020) and takes into account the tools or cognitive artefacts used to mediate learning, such as digital interfaces (Nardi, 1996). Although CSCL does not refer to a single theory of learning, its activity theory-based elements, such as expansive learning, are significant in a context of virtual reality and computer-supported collaborative learning (Stahl, Hakkarainen, 2020).

2.1 Focus on Activity theory for learning in digital museum

It was born in the 1960s, within the historical-cultural school of Vygotskij thanks to his pupils Leont'ev, Rubinstejn, and Laurija, among others, who emphasized that internal cognitive activities cannot be fully understood if analyzed separately from the external ones; consequently, the mechanisms of internalization and externalization must be studied jointly. Activity theory is composed of several key elements: (1) the subject/individual participating in the activity, (2) the object, not tangible

like a tool but rather the «*object*» of direction that motivates the activity, (3) actions as purpose-driven conscious processes to reach the object, and (4) operations as internalized subconscious processes to reach the object (Leont'ev, 1978). Instead of simply considering the individual and the object, Engeström (1987, 2016) suggests that an activity contains three entities: the individual, the object, and the community within a form of learning called expansive learning. He (2016) argues that activity theory provides a more complete alternative to Kolb's (1984) experiential learning cycle and Nonaka and Takeuchi's (1995) four modes of knowledge conversion since it explicitly considers the cultural contexts of social learning spaces and differentiates between education and self-guided learning. Activity theory allows us to better understand interaction with the interface as a sequence of actions and processes (Cranton, 2016; Kuutti, Bannon, 1993) within constructivist learning environments (Jonassen and Rohrer-Murphy, 1999). Although activity theory is often analyzed with respect to the individual— albeit with some input from the surrounding culture and community— there are interpretations for which social interactions are significant within the learning sciences (Engeström et al., 1999). In the context of constructivism and experiential learning, it is important to be able to enter real world situations and authentic environments. We can also observe that memory is closely associated with the environment (Chun, Jiang, 1998, 2003; Smith, 1979), and the power to recreate these «spatial contexts» as virtual spaces (or virtual environments) in virtual reality has great potential in the form of virtual «memory palaces» (Krokos et al., 2018).

3. Towards a digital museum

Museums are currently facing a decline in interest and attendance by young people. As a response, some museums are organizing *personal and interactive experiences* (Marketing Museums to Millennials, 2010). This has led to experiments on the use of interactive methods to attract and engage young people. Some interesting examples of the use of virtual reality technologies in museum exhibitions (Alexander et al., 2013; Dreams of Dali: Virtual Reality Experience – Salvador Dali Museum, 2016; Lacoche et al., 2017; Snibbe, Raffle, 2009; Sylaiou et al., 2010) often use reality-based interactions (Jacob et al., 2008) to create more embodied interactions.

Recent research investigated how the manipulation of virtual artifacts can help emulate the social experience of visiting the physical museum (Li et al., 2018), as well as the use of fiction in both virtual and physical museum contexts (Hoang, Cox, 2018). Certain types of media, such as *social immersive media* installations, focus on Reality Based Interactions (RBI) that scale from one to a number of participants (social scalability) and may be useful in future social class research focused on learning

experiences that require the simultaneous use of digital technologies. The principles of «immersive social media»— visceral, responsive, continuously variable, socially scalable, socially familiar, and socially balanced (Snibbe, Raffle, 2009) — seem relevant for virtual socio-educational contexts. Dede (2009) notes that understanding the strengths and limitations of these immersive media for education is important, especially because situated learning appears to be a promising method for learning sophisticated cognitive skills, such as using inquiry skills to find and solve problems in complicated situations. Digital tools, then, can be of great use in the development of Virtual Learning Environments. VLEs, limited only by the creators' vision and by a computer's hardware, allow for significant opportunities to experience otherwise inaccessible situations and environments. The motivation to implement these digital tools comes from our ability to use 'embodiment' to aid learning through three constructs: (1) the amount of sensory-motor involvement, (2) the consistency of gestures and to-be-learned content, and (3) the amount of immersion experienced by the user (Johnson-Glenberg, Megowan-Romanowicz, 2017). Due to the absence of standardization and attempts to replicate research results, there is a conflict within the literature on what are the best practices for digital education/teaching. Merchant et al., (2014) found that virtual games were more effective as learning tools and that, surprisingly, individual play was more effective than collaborative play. However, these findings could be challenged by other works that suggest that individual play is also essential for promoting group activities (Sawyer, 2017). There is a lack of conclusive evidence to suggest that virtual/3D learning environments support learning effectively (Dalgarno, Lee, 2010). Fowler (2015) points out that more concrete guidelines for creating digital learning content would help. Merchant et al., (2014) conclude that, although virtual education is effective, there are aspects to be guarded such as repeated assessments that reduce learning outcomes. These types of difficulties in validating learning outcomes through educational activities in museum digital environments are well summarized by Dede and Richards (2017), who recognize that designing, evaluating, and creating digital learning content, within various learning contexts and with various users, it is challenging but of fundamental importance for the future.

4. On using the digital and on social learning spaces

There are many interesting aspects to consider when trying to create digital applications in social learning spaces. In general, three main areas of interest and directions for research emerge unambiguously from scientific literature: 1. accessibility; 2. the unclear interaction between parallel realities (virtual and physical) in learning; 3. the preferred educational theories and methodologies within social learning spaces. Furthermore, we must also observe and verify through experimental

rigor how the digital can help improve educational practices within these learning contexts (Dalgarno, Lee, 2010; Fowler, 2015).

Researchers note that there are not enough real-world case studies on the use of digital technologies for learning in social settings (Markowitz et al., 2018) and that it is difficult to test these technologies in authentic contexts (Dede, Richards, 2017). Accessibility will always be a significant concern because learning is not exclusive to a few people, but to everyone. When we consider social learning spaces, such as museums, we must also consider how to make sure that the technology in use within these spaces improves learning rather than hindering it. Studies suggest three specific areas where further exploration can help make the use of the digital in social learning spaces better follow the principles of Universal Design for Learning (UDL): platform scalability, social scalability, and the scalability of reality.

- *Platform scalability* refers to a system capable of adapting to different platforms (desktop, mobile, large screens, etc.). This is comparable to a virtual form of UDL, which suggests how to increase the accessibility of learning materials through (1) Multiple Means of Representation, (2) Multiple Means of Expression, and (3) Multiple Means of Engagement (Rose et al., 2006). By being supported by multiple platforms, digital content can potentially be more accessible with multiple means of expression. Further research in this area would help understand how interactions, navigation, and embodiment in an educational setting can change as you move across platforms. This is fundamental in social learning spaces since the state of research on the use of public technology suggests that social embarrassment can limit the use of non-familiar devices (Brignull, Rogers, 2002); the embarrassment of physically moving with a viewer could also be a problem in the context of virtual reality (Rogers et al., 2019), as the reluctance to wear HMD-VR in social spaces starts to emerge (Outlaw, Duckles, 2017; Southgate et al., 2019).
- *Social scalability* is based on Snibbe and Raffle's (2009) definition. Within a museum context where «interactions are designed to share with others... users' interaction, representation, engagement, and satisfaction should become richer as more people interact» (Snibbe, Raffle, 2009). This definition could expand to include multi-user applications that support a variable number of remote (to reduce geographic barriers) and co-located (in the classroom) users working together towards shared goals (Otto et al., 2006; Roberts et al., 2003). Future research should focus on how social scalability affects co-presence and learning outcomes, on what socially scalable interactions look like in the context of learning, and on how remote and local users communicate and interact in virtual spaces.
- *Reality scalability* refers to the concept of an application that allows for both virtual and augmented reality perspectives. Some studies

explore «collaboration in mixed space» (Grasset et al., 2005) and collaborative interfaces (Grasset et al., 2006), but there are few examples of the exploration of these techniques in education. The scalability of reality can become increasingly important in remote collaboration and co-localized collaboration among peers. As noted in the previous section on platform scalability, allowing students to use an AR over VR platform may be preferred as they may be more socially aware. In this context, future research could explore the possible learning advantages of adopting non-egocentric points of view, how to design virtual learning environments (VLE), and how to synchronize users, environments, and real/virtual objects across physical and virtual locations.

5. Real/Virtual, cultural learning, and social activity: some possible future scenarios

Scientific literature points to the emergence of important areas of work on how virtual work can affect our reality, on how identification in virtual worlds can change our behavior (Yee, Bailenson, 2007), on how performance can being influenced by others through social facilitation and social inhibition (Miller et al., 2019), on how even virtual spaces can change our behavior (MacIntyre et al., 2004; Proulx et al., 2016), and on how the physical learning spaces we live in can influence our virtual behaviors. The very nature of the use of digital technology can inhibit participation and comfort (Brignull, Rogers, 2002; Outlaw, Duckles, 2017; Rogers et al., 2019) but, despite the existence of a few studies, it is still too early to state how to prevent collisions in shared virtual spaces (Langbehn et al., 2018; Scavarelli, Teather, 2017). Connectivism and activity theory suggest that our digital tools and the socio-historical culture surrounding the publics become an intrinsic part of the learning process; we should consider how these very processes apply to both virtual and physical worlds, since they are not mutually exclusive entities, but intertwined in parallel realities that influence each other and each individual within them (Stevenson Won et al., Nd).

How does the interaction among virtual and physical spaces help or hinder learning? Does the interaction among physical and virtual realities require the construction of physical learning spaces built with the modulization of the virtual world in mind?

These are some of the questions that have informed the research selected in this critical review and that will have to be addressed in the future. Although most VR/AR projects in learning depend on constructivism, experiential learning, and/or social cognitive theory, there are additional theoretical and methodological foundations that can help understand virtual and physical environments within a socio-cultural context. Activity theory, in the form of expansive learning, not only includes digital tools and objects/artifacts as an intrinsic part of the

learning process, but also the socio-historical properties of learning spaces (Engeström, 2016; Stahl, Hakkarainen, 2020). This could lead to some interesting explorations into the interaction among the social, spatial, and cultural aspects present in both virtual and physical learning spaces, and into how to better create digital content that recognizes them. The interconnected learning processes among individuals and their actions, social, and spatial environments are complex and, as human behavior can change in virtual environments, we may need to look at additional learning theories that better encapsulate how this «digital» learning takes place. It might be useful to question the effect of sociocultural contexts on learning performance in digital environments and explore the application of activity theory in social learning spaces— such as those of the virtual museum— and to parallel realities (i.e. physical and virtual).

Conclusions

This literature review clearly points to the fact that, in the era of co-creation and sharing of content, to keep on thinking of knowledge and learning as pre-packaged products is obsolete. Culture is made of both symbolic and material artifacts that mediate people's interaction with the world. Our relationship with the world is predicated on a double reality, natural and cultural: «There are no 'natural' practices: every practice to which we are introduced and in which we participate contains elements and tools (language, signals, mental models, etc.) that culturally mediate our relationship with the world» (Zucchermaglio, 1996, 16). Recent research on learning theories agrees that it is not useful to distinguish between external, or practical, and internal, or cognitive, artifacts, since an external representation can only become so through language (dialogue, gesture, writing, etc.) and, conversely, external processes can be internalized. In this regard, activity theory appears very useful for future explorations, as it is both an object of study and a method of research.

With respect to the international landscape, the reviewed research converges on some key directions regarding the use of digital technologies in educational environments— be them physical, virtual, or mixed— starting from the museum. The aforementioned points are as follows:

1. To deepen the research on the impact of technologies on cultural practices and social models: from the reviewed scholarship it emerges that pertinent research is still lacking or is mainly occupied with technological and commercial aspects.
2. To pay particular attention to the relationship between real/virtual social environments: the two environments influence each other by creating forms of communication and interaction that open up to new future scenarios.

3. To prioritize human interactions when using digital technologies: digital technologies can promote learning, but their use must be conceptualized through the logic of relational, individualized, and guided teaching and learning.
4. To prioritize the creation of a teaching and learning method that takes advantage of digital technologies in an inclusive and multidisciplinary way. In this sense, the contribution of cultural field planning proposed by supranational government institutions is fundamental to reduce methodological diversities, guaranteeing the maximum equity of access to different publics and the best use of cultural contents. There is a lot of work to be done to standardize the shared terminology surrounding digital education, to measure its effectiveness, and to identify the basis on which pedagogical projects should be built. Research clearly shows that technology is simply a promising and stimulating tool for learning that can be effective when used in parallel with traditional methods, to augment and improve existing educational methods rather than replace them. Despite this, we note the existence of untapped potential in combining traditional teaching with new technologies to help «new and old» students, that is the different audiences of museums.
5. To think and design digital technologies that support, without hindering it, the use of digital content: technology can often increase the gap between competent/incompetent users and between holders/non-holders of technology. Technology should be considered part of the educational project, but it is common to witness the erroneous practice of projecting technology onto an existing traditional lesson.

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