INCLUSIVE AND CHANGE-ORIENTED MUSEUMS: A CONSTRUCTIVIST APPROACH WITH AUGMENTED REALITY

MUSEI INCLUSIVI E ORIENTATI AL CAMBIAMENTO: UN'APPROCCIO COSTRUTTIVISTA CON REALTÀ AUMENTATA

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ABSTRACT

The educational role of museum directors, curators, and staff is characterized by their principled and proficient behavior, highlighted by ethical and professional communication, and their commitment to refrain from acting solely as collectors in line with ICOM's recommendations. By prioritizing community involvement, they aim to offer diverse experiences encompassing education, enjoyment, and the "dissemination" of knowledge. The integration of AR within the constructivist framework of a museum emerges as a promising approach, capable of fostering transformative experiences to become an "agent of change" in visitors, where museum spaces are not just places of exhibition, but rather true interactive laboratories.

Il ruolo educativo dei direttori, curatori e dipendenti dei musei è caratterizzato da comportamento prudente e competente, con un'enfasi sulla comunicazione etica e professionale e l'impegno a non agire solo come collezionisti, aderendo alle raccomandazioni dell'ICOM. La priorità nel coinvolgimento della comunità mira a offrire esperienze variegate di educazione, svago e diffusione della conoscenza. L'integrazione della Realtà Aumentata (AR) nell'approccio costruttivista al museo rappresenta un promettente approccio, capace di favorire esperienze trasformative e diventare "agente di cambiamento" nei visitatori; con queste premesse, gli spazi museali non sono più solo luoghi di esposizione, ma veri e propri laboratori interattivi.

KEYWORDS
Augmented Reality, Museum Education, Constructivism, Edugame Design.
Realtà Aumentata, Didattica Museale, Costruttivismo, Design di Edugame.

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Introduction

As educators fulfilling one of their institutional functions, museum directors are invited to engage in thoughtful deliberation regarding the strategic incorporation of augmented reality technology within the museum context, with the aim of maximizing visitors' learning potential and enhancing their experiential outcomes. In fact, a museum is "a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets, and exhibits tangible and intangible heritage. Open to the public, accessible, and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally, and with the participation of communities, *offering varied experiences for education*, enjoyment, reflection, and knowledge sharing."[1]. In their educational role, museum directors, curators, and museum staff operate and communicate ethically and professionally, with the participation of communities, offering diverse experiences for education, pleasure, and knowledge sharing. Nevertheless, let us take a step back for a preliminary analysis.

1. Enhancing Museum Education Through Augmented Reality: A Reflective Approach based on a Case Study

Visiting a museum always evokes various emotions: admiration, wonder, curiosity, but sometimes also boredom and some doubts for those who cannot connect with the exhibited collection. For a tourist, a museum is a place that "completes" the visit to a city or a territory, just like the landscapes and typical street food. For a researcher involved in educational technology, visiting a museum becomes a moment to imagine new technical solutions to make a museum more accessible and educational, hypothesizing strategies to make an exhibited collection accessible. This work is based on a visit conducted during the visit to the Neues Museum in Biel, Switzerland, which exhibits a vast collection on multiple floors, including different collections that are linked with the city. Specifically, the NMB Neues Museum Biel concentrates on the cultural history of the region spanning from prehistory to the present day. The museum features an archaeological collection of artifacts from the region, a collection related to the

[1] https://icom.museum/en/news/icom-approves-a-new-museum-definition Retrieved [August 12, 2023, 2023]

city's industrial and watchmaking history, and a collection of paintings[2]. The focus of this article will be on the part about the watch collection that is definitely unique.

The technology that will be considered to foster museum education, in this case, is augmented reality, which offers numerous educational opportunities and involves both individual visitors and communities that want to promote their cultural heritage. On an individual level, it allows visitors to explore museums interactively, personalizing their learning path based on their interests and levels of knowledge. At a collective level, it fosters collaborative learning and the sharing of experiences among visitors. At an institutional level, museums can use augmented reality as a tool to expand access to education. Furthermore, augmented reality enables users to actively interact with artworks, exhibited objects, and related information. This active engagement stimulates both the cognitive and emotional aspects of the individual. Through the use of augmented reality, users can dynamically explore museum content, interpret it, ask questions, and participate in engaging experiences that foster a deeper understanding of art and culture. In this way, museum education with augmented reality can promote critical awareness and empathy, encouraging individuals to become agents of change in society. If one considers the practice of education as intentional, it goes beyond the mere application of theories through the organization and management of means, but rather as a regulatory critique of action, education is conceived as an action that responds to rationality internal to praxis, which determines the elaboration and redefinition of models, patterns, behaviors, and attitudes.

Technology plays a role in supporting this educational activity by providing educational multimedia content that facilitates the teaching and learning process. This requires critical reflection on content design, visitor-object interaction, and the use of digital technologies to create an effective educational environment. In this work, the concept of classic constructivism (Bruner, 1966, 1982; Bruner, Haste, 1987), as well as, Hein's research concerning the analysis of museums from a constructivist point of view is very interesting (Hein, 1998, 2000, 2001, 2002, 2006). Next, a case study will be presented: a section of a hypothetical museum dedicated to wristwatches, which by its nature is rather static, but can become interactive through the introduction of a video game system designed to convey information and concepts through a specially developed application, which in this paper will only be exposed at the *design* level and has not been implemented except in terms of *software* development.

[2] https://www.myswitzerland.com/en/experiences/neues-museum-biel-nouveau-musee-bienne Retrieved [August 12, 2023, 2023]

2. Constructivism: the importance of "imaginary worlds" in App's design

Constructivism is a current psycho-pedagogical thought that, over the course of the 20th century, has gradually changed the way the learning process and educational practice are conceived. According to constructivism, knowledge is not simply a copy of reality, but rather a product of the cognitive activity of the individual, who constructs his or her own knowledge through interaction with the environment. It is especially the social environment that plays a crucial role in the acquisition of knowledge, through interaction with other individuals and the construction of a shared language. In this sense, constructivism also has a strong social value, as it values collaboration among people and the sharing of knowledge. Jerome Bruner's contribution to the development of constructivism has been significant (Bruner, 1966, 1982; Bruner, Haste, 1987). According to him, knowledge is not passively acquired from the surrounding environment but is actively constructed by the mind of the individual through his or her interaction with the world. Learning is thus an active process in which students actively participate in the learning experience and engage in *problem-solving* processes. The American psychologist highlighted the importance of culture and social context in the construction of knowledge and developed the concept of *scaffolding* (Searle, 1984; Shanker, Taylor, 2001; Gonulal, Loewen, 2018), which is the support provided by the educator or an adult to help the student develop his or her cognitive skills. Bruner stressed the importance of narratives and symbolic representation in the construction of knowledge, stating that knowledge depends on the cultural and social context in which it is developed. We will now examine the reasons that led to the "overcoming" of previous psycho-pedagogical models to arrive at constructivist theory.

Positivistic epistemology, which characterized museums in the twentieth century, limited human knowledge to the mere discovery of an already existing static world; this approach is clearly reflected in science museums. This limitation, which recalls a "transmissive" educational model, can be overcome through the adoption of constructivism, in fact, it recognizes that knowledge is actively constructed through the interaction between the subject and the object of study, the learning process is a continuous and evolving action, while in constructivism, all perceiving is building and unbuilding patterns that allow us to *grasp more or less of the world* (Ariano, 2019, p.19). According to the perspective prior to constructivism, the attainment of knowledge was equated with the discovery of the external world (Ibid., p.63), and the method of attaining such knowledge was based on the constant increase of perceptual activities, aimed at maximizing the teaching-

learning process. This process, in a positive feedback perspective, was calibrated to the aforementioned procedures; doing so created a paradox: knowledge was a path to the elimination of subjectivity, subjectivity, on the other hand, being the *fuel of* curiosity and creativity necessary to progress in the field of knowledge subject (Ibid.) of any museum. Fortunately, constructivism has restored the proper dignity to the subject by asserting that each subject interacting with the object shapes it (Ibid.), a shaping that takes on literary significance in the case where the museum in question is embedded in a three-dimensional, interactive virtual environment. Constructivism could be summarized as follows: ever since life appeared on earth, living beings have spontaneously invented more and more complex formulas of life and human beings have been able to call into existence things that did not exist before (Ibid.).Before constructivism, in the midst of positivism, people lived in a world in which man was thought to be only able to discover what is there; the concept of discovering until now has not been given its proper value, despite the fact that each person with his ability to invent has transformed the face of the earth. Maybe people are not ready to experience the *constructivist revolution*. If we take it seriously we get chills both of the heights, in discovering the powers that man has and the responsibilities of those powers. With constructivism, man does not simply have infinite visions of the one world, but calls into existence some worlds among the infinite possible ones. Such an assertion radically transforms our view of the world (Ibid., p.69), and again it can be stated that constructivism, starting from the co-essentiality of subject and object leads us to the conclusion that infinite subjects construct infinite worlds, and above all that in constructivism these worlds emerge, they are not discovered (Ibid., p.70).

According to Sibilio's (2020, pp. 56-61) contributions, the theory of constructivism applied to the educational field can be made explicit. This model predicts that the individual is able to construct knowledge in relation to the learning situation, and is based on the interaction between teacher, learner, and context. This approach denies the universality of the teacher's knowledge and recognizes learning as a personal construction of knowledge, which requires the teacher to study different forms of learning in order to adopt a learner-centered, rather than teacher-centered, approach. According to this idea of constructivism, the knowledge process is the result of subjective interpretation of the interaction between teacher and learner, and recognizes that there is no single objectivity of reality, but there are different levels of interpretation of objects, subjects, relationships, and events. Furthermore, constructivism views teaching as a collective and participatory construction of knowledge, which can also result from the sharing of meanings in different contexts. It introduces the concept of

"meaningfulness of learning," which must be active, collaborative, conversational, reflective, contextualized, intentional and constructive in order to be reused on the learning level. Constructivism favors a mode of learning that is shared, refined, and evolves on the basis of personal and collective interpretive capacity, and recognizes knowledge as having a value including the possible meanings attributable by each person. Teaching from a constructivist perspective is not based on a single methodology, but adapts to the interpretive capacity of the teacher and the learner. According to Jonassen (Ibid.), in order to promote the construction of meaningful learning, teaching should avoid reproductive modes and forms of complexity reductionism, grounding itself in the authenticity of experience, providing environments and conditions that foster the learning process through the development of plural interpretations, reflexivity about learning in relation to context and type of knowledge, and the cooperative dimension of learning. In brief, the theory of constructivism in education allows us to define a useful procedural way of acting in a given situation in order to promote learning, with the understanding that each construction of knowledge, skills, or competencies may be different from one to another. Thus, constructivist teaching actions, such as explaining and defining a concept, can be used to cope with difficulties arising from learners' individual differences (Ibid., p.68).

3. The Constructivist Museum according to George Hein

George Hein's constructivist museum concept (1998, 2000, 2001, 2002, 2006) is based on the idea of creating museum spaces that are not just places of exhibition, but rather true interactive laboratories. These museum spaces should engage visitors in an active learning and knowledge-building experience. The visitor should not just be a passive spectator, but rather an active participant in the process of learning and building their own knowledge. In this type of museum, visitors should be involved in hands-on activities, experimentations, and interactions with the exhibits in order to develop their creativity and stimulate their critical thinking. The constructivist museum should also have a strong focus on social inclusion, seeking to engage visitors of different ages, cultural backgrounds, and educational levels. Therefore, Hein's constructivist museum concept focuses on creating an active, participatory learning experience that engages visitors in hands-on activities and stimulates their creativity and critical thinking. Hein's work has brought to light a number of important considerations regarding the role of constructivism in the interaction between visitors and the museum. First, it emerged that constructivism

represents, maybe, the most promising theory for explaining the complex dynamic between visitors and the museum. In addition, Hein (2002) pointed out that John Dewey had already glimpsed the nature of constructivism and the relationship between education and society, stating that experience is fundamental to authentic education, but that it must be planned and structured to become a teaching-learning process. Moreover, it was noted that active visitors gain knowledge through interaction with the museum environment and that active participation must occur through interaction with exhibits, although in some cases sensory interfaces must be used in order to interact with original works. Finally, Hein emphasized the importance of museums as *interpreters of our culture*.

Figure 1. Neues Museum in Biel, Switzerland, a room dedicated to luxury watches[3,4].

One of George Hein's major contributions is to classify museums according to four educational approaches:

1. the *systematic* museum;
2. the *ordered* museum;
3. the *discovery* museum;
4. the *constructivist* museum.

[3] In accordance with the guidelines titled "Copyright Law - Practical Knowledge for Museums" by the Swiss Museums Association, the reproduction of artworks, even for internal documentation purposes and scientific endeavors, is not permissible without prior authorization. The same restriction applies to reproductions intended for informational purposes, such as for inclusion in a database. It is to be emphasized that, in this response, no photographs of the mentioned author have been included. More info: https://www.museums.ch/it/assets/files/dossiers_i/Standards/VMS_Urheberrecht_20_I_web_neu.pdf Retrieved [August 12, 2023, 2023]

[4] Instead, a link has been provided where one can admire the Luxury Watch Room of the Museum: https://www.madeinbienne.ch/post/the-amazing-rolex-collection-at-the-nmb Retrieved [August 12, 2023, 2023]

The *systematic* museum uses an educational didactic and exhibition mode, characterized by sequential exhibits with a beginning and an end that "tell a story" and offer no alternative explanations. Usually, labels or panels, explains what is to be learned and is organized hierarchically, from the simple to the complex. In contrast, the *ordered* museum, although similar to the previous one, does not support objective truth and includes reinforcement components that reward the appropriate response.

The *discovery* museum, on the other hand, allows visitors to explore and learn by seeing and doing, rather than being told. Although the displays ask questions that prompt visitors to discover the answer for themselves, visitors engage in activities that lead to accepted results and always reveal conclusions and concepts. However, Hein promotes the *constructivist* museum as an accessible place, where structure and presentation depend on the visitor's educational needs (D'Alonzo, 2015; Aiello, Di Tore, Pace, Sibilio, 2016), not on the properties of the objects on display. The museum presents various perspectives and serves a wide range of learning styles, allowing visitors to experience and connect with objects and ideas through a wide variety of activities and experiences that relate to their life experiences and encourage social interaction. Learning in a museum can be divided into four categories:

1. *cognitive* learning: the learning of new knowledge and information through the observation of objects, exhibits, films, etc.;
2. *social* learning: learning through interaction with other visitors, interpreters, or museum educators;
3. *affective* learning: learning about emotions, feelings, and experience through interaction with museum objects and exhibits;
4. *psychomotor* learning: learning skills and competencies through physical interaction with museum objects and exhibits.

He also argues that these types of learning are interconnected and influence each other. In addition to this, Hein argues that the visitor's experience is influenced by the physical environment of the museum, the presentation of the exhibits, and the interpretation provided by museum professionals (Hein, 1998).

The use of statues, perhaps resembling those found in wax museums, to represent the working environments of watchmakers and wristwatch factories presents certain limitations compared to augmented reality, which activates a dynamic representation without removing the statues themselves. Firstly, statues are static and lack the ability to capture the dynamic nature of the working

environments. They cannot effectively convey the movement, activity, and intricate processes involved in watchmaking and watches production. In contrast, augmented reality can simulate and animate these elements, providing a more immersive and realistic experience. Secondly, statues have spatial limitations. They are confined to a fixed physical location and cannot represent multiple scenes or perspectives simultaneously. On the other hand, augmented reality allows for the virtual placement of interactive elements within any given space, enabling users to explore different angles, zoom in on details, and interact with the virtual representation of the working environments. More in detail, statues may not accurately capture the fine details and intricacies of the machinery, tools, and materials used in watchmaking and wristwatch production. Augmented reality, on the other hand, can present highly detailed virtual models and interactive information overlays, providing users with a more comprehensive understanding of the processes involved. Another limitation of statues is their static nature. Watchmaking and watches factories have evolved significantly throughout history, with advancements in technology and manufacturing processes. Statues alone cannot effectively depict these changes, while augmented reality can dynamically present different historical periods, illustrating the evolution of the industry and its working environments.

4. The emergence of future technological resources and their potential application in the Constructivist Museum

The silicon age has brought a revolution in emerging digital technologies, including augmented reality, haptic sensors, and virtual reality viewers. These technologies have merged with digital screens, giving the Museum new freedom to explore art and science in innovative and engaging ways for the public. Culture blends seamlessly with technology, creating an immersive and engaging experience for visitors. Emerging digital technologies are those that are evolving and developing rapidly, offering new possibilities and opportunities for innovation in various fields. Among the most important emerging technologies are:

1. *virtual reality*, is a technology that creates a virtual computer environment that simulates a real physical space, allowing the user to interact with it through a visor or glasses;
2. *gesture and eye movement recognition*, is a technology that allows users to interact with objects on display in museums through their own body and eye movements;

3. *tactile sensors and controls*, it allows users to physically manipulate objects on display in museums through hand controls or sensors that detect hand movement;
4. *augmented reality and digital twins* are technologies that integrate digital objects and information into a physical environment, creating a multichannel experience for museum visitors;
5. *mind-managed sensors* are a technology still under development that will allow users to interact with objects through thought, detecting the user's brain waves and interpreting them as commands.

5. Interactive exploration of the wristwatches room through the adoption of augmented reality technologies

The adoption of augmented reality technology appears to be an appropriate option to provide a more immersive and interactive experience for visitors. For example, there is a commercial app[5] that allows visitors to view the desired watch in real-time through the camera of their smartphone or tablet, so they can observe what the watch looks like on their wrist without having to physically try it on. According to Donald Norman (2004), one of the pioneers of cognitive and emotional design that evoke positive and empathetic emotions in users. The goal is to go beyond the mere functionality of the product to create an experience that also engages users' feelings and emotions. An idea of emotional design, based on Norman's proposition and adapted to the specific case, could be to design objects that encourage learning and creativity. The toy could be designed to be friendly, colorful, and visually appealing. It could have a virtually ergonomic shape (imagining a watch on the wrist that doesn't actually exist but gives a sense of reality to the sight) to facilitate an emotional response and an intuitive interface that engages observers and gives them the sense of wearing and using the collection displayed in the well-known display case, appreciated for the rarity and value of every single watch. Furthermore, the App could react emotionally to the actions of the virtual wearer of the object. For example, it could provide feedback when users do something correctly or achieve a goal. The main objective would be to create an emotional connection between the visitor and the augmented reality gaming App, thus stimulating interest, curiosity, and joy in playing. This type of emotional design aims to create an engaging gaming experience that goes beyond the mere functionality of the app, eliciting positive emotions in museum visitors

[5] https://arcom.dev/realta-aumentata-ar-per-orologi/ Retrieved [August 12, 2023, 2023]

and promoting cognitive and emotional development. Below, is a possible Design[6] concept for an augmented reality App for a museum of historic luxury watches:

1. *Title*: Timepiece Explorer.
2. *Overview*: timepiece Explorer is an innovative augmented reality App designed to enhance the visitor experience. The App leverages AR technology to allow users to visualize luxury watches on their wrists, highlighting their unique features, strengths, and weaknesses, and providing educational insights. To go beyond a mere *wonder* effect, Timepiece Explorer incorporates gamification elements (Hamari, Koivisto, Sarsa, 2014; Caponetto, Earp, Ott, 2014; Saleem, Noori, Ozdamli, 2022) to engage users and promote interactive learning.
3. *Key Features*. Enhanced Information Overlay: Timepiece Explorer utilizes AR overlays to present detailed information about each watch. Users can tap on specific elements of the watch, such as the movement, complications, and materials, to access comprehensive descriptions and historical context. This feature offers educational insights into the technology, craftsmanship, and historical significance of the watches, enabling visitors to develop a richer appreciation for luxury timepieces.
4. *Gamified Learning Experience*: to transform the App into an educational gamified tool (Saleem, Noori, Ozdamli, 2022), with gamification elements. Users can participate in interactive challenges and quizzes related to watch history, technology, and design. To approach as closely as possible to what is claimed in formal learning environments when referring to real-world tasks (Gentili, 2016, p.10), the distinctive and indispensable element in the evaluation is the fulfillment of an assignment, the realization of a project or task, or the construction of something tangible or engaging in performance to ensure that competence has been acquired (Ibid.). By completing these activities, visitors can earn virtual badges and unlock additional content. More in detail, Assessing learning doesn't merely involve checking for recalled knowledge, but it is necessary to identify and valorize processes of critical thinking, problem-solving, metacognition, efficiency in tasks, teamwork, reasoning, and lifelong learning (Tessaro, 2014, p.78). This gamified approach encourages active learning, making the museum visit an enjoyable and educational experience.

[6] For ease of reading, the app design is written in the present verbal tense, not the conditional tense.

5. *Social Sharing and Community Engagement*: timepiece Explorer allows users to capture and share their virtual try-on experiences on social media platforms. This feature promotes community engagement and extends the reach of the museum's exhibits beyond physical boundaries. Users can also participate in online forums and discussions to share their insights, ask questions, and connect with fellow watch enthusiasts, fostering a sense of community, which is as important in the educational field (Harris, 2006) as it is in non-formal educational spaces such as museums, and knowledge exchange.

Overall, this App transforms the traditional museum visit into an immersive and *educational journey*, A journey that transcends the technical limitations of the virtual systems of the past decades (McKay, Van Schie, Headley, 2008). Leveraging augmented reality, detailed information overlays, gamification, and social engagement provide visitors with a deeper understanding and appreciation of luxury watches. Through interactive learning experiences, users become active participants in their exploration of horological craftsmanship and heritage.

Figure 2. A hypothetical application[7] aimed at providing an immersive experience during a visit to the wristwatch room of a hypothetical museum called *Luxury Watch Museum*, providing historical information and trivia regarding the model tested virtually.

[7] adapted from https://www.perfectcorp.com/business/products/ar-watch and from https://arcom.dev/realta-aumentata-ar-per-orologi/ Retrieved [August 12, 2023, 2023] All the websites, apps, and images mentioned here belong to their rightful owners. Third-party trademarks, product names, trade names, corporate names, and company names mentioned might be trademarks owned by their respective owners or registered trademarks of other companies. They have been used for explanatory purposes only and with no intention of infringing on any existing Copyright rights.

Below, is a possible Design concept for an augmented reality App to understand how Watchmakers work[8]:

Figure 3. Photos of Working Watchmakers[9]. In a museum, it is essential to convey the nature of a historical occupation when exhibiting an old profession. Therefore, instead of relying solely on wax statues, incorporating videos or, even better, virtual or augmented reality experiences becomes crucial.

1. *Title*: WatchCraft AR
2. *Overview*: WatchCraft AR is a cutting-edge augmented reality App designed to provide an immersive and educational experience at the *Luxury Watch Museum*. The App utilizes AR technology to bring to life wax statues representing watchmakers and workers in a watch factory, showcasing the process of watchmaking and repair. It aims to go beyond a mere *wonder* effect and deliver an engaging and educational experience for museum visitors.
3. *Key Features*: Interactive wax statues. WatchCraft AR features lifelike, interactive statues of watchmakers and workers in a watch factory, which are already available inside the museum and which were once surely the best technology to give a realistic (unfortunately static) effect to human activities. Users can explore the statues from different angles, observing their actions and techniques as they construct and repair watches. The App uses AR to overlay step-by-step visualizations of the

[8] For ease of reading, the app design is written in the present verbal tense, not the conditional tense.

[9] The photographs are under an open license and available at the following addresses: https://www.wallpaperflare.com/italy-sanremo-watch-hand-jeweler-occupation-one-person-wallpaper-eebln Retrieved [August 12, 2023, 2023]
https://www.pexels.com/photo/photo-of-a-working-watchmaker-16216124/ Retrieved [August 12, 2023, 2023]

watchmaking process, allowing visitors to understand the intricacies and craftsmanship involved.

4. *Repair Simulation*. WatchCraft AR enables users to virtually participate in watch repair simulations. Through the App, visitors can select a damaged watch and engage in a step-by-step interactive repair process, guided by the virtual wax statues. This hands-on experience helps users comprehend the intricacies of watch repair, identify different components, and understand the skills required for this craftsmanship.
5. *Gamified Challenges*. To enhance the educational experience, WatchCraft AR incorporates gamification elements. Users can participate in challenges and quizzes related to watchmaking, testing their knowledge and skills. By successfully completing challenges, visitors earn points and unlock additional content, encouraging them to actively engage with the App and deepen their understanding of the craft.
6. *Community Engagement*. WatchCraft AR includes a community section where users can connect with fellow enthusiasts and professionals in the watchmaking field. Users can join discussions, share insights, and seek advice from experienced watchmakers, fostering a sense of community and knowledge exchange. This feature encourages visitors to continue their learning journey beyond the museum visit.
7. *Guided Tours and Curated Experiences*. The App offers guided tours and curated experiences that allow visitors to explore different aspects of watchmaking. These tours can focus on specific time periods, watchmakers, or techniques, providing in-depth information and a curated narrative that enriches the visitor's understanding of horological craftsmanship. By combining interactive wax statues, strengths and weaknesses analysis, repair simulations, gamified challenges, community engagement, and guided tours, WatchCraft AR creates an educational and immersive experience for *Luxury Watch Museum* visitors. The App brings the art of watchmaking to life, enabling users to appreciate the craftsmanship, understand the techniques, and gain insights into the challenges and innovations in the industry.

6. Enhancing Museum Learning through Augmented Reality: A Constructivist Perspective

Both the "Timepiece Explorer" and "WatchCraft AR" apps align with the scaffolding of constructivist teaching and learning. Constructivism is a learning theory that emphasizes the active construction of knowledge by the learner through interaction with the environment and the integration of new information with existing mental structures. The analysis will be conducted to assess how both Apps reflect the principles of constructivist teaching: 1) *Active Learning*: both apps encourage active learning by providing interactive experiences for museum visitors. Instead of passively observing exhibits, users engage with the content through augmented reality (AR) interactions, quizzes, challenges, and discussions. This active engagement promotes a deeper understanding of the subject matter; 2) *Authentic Learning Experiences*: both apps aim to create authentic learning experiences. In "Timepiece Explorer," users can virtually try luxury watches on their wrists, exploring their features, strengths, and weaknesses, which mirrors a real-world experience. In "WatchCraft AR," users can interact with lifelike wax statues of watchmakers and engage in watch repair simulations, providing a sense of authenticity to the learning process; 3) *Problem-Solving and Critical Thinking*: both apps incorporate analysis and evaluation components. "Timepiece Explorer" includes an analysis section for each showcased watch, where visitors can assess strengths, weaknesses, and unique selling points. "WatchCraft AR" presents the strengths and weaknesses of specific watchmaking techniques and tools. By considering these aspects, users are encouraged to think critically and make informed judgments. 4) *Building on Prior Knowledge*: both apps leverage visitors' prior knowledge and interest in luxury watches and watchmaking. "Timepiece Explorer" provides historical context and educational *insights*, building on users' existing knowledge about watches. "WatchCraft AR" showcases the evolution of techniques over time, connecting visitors' prior knowledge to the development of watchmaking; 5) *Social Interaction and Collaboration*: both apps promote social interaction and collaboration. "Timepiece Explorer" allows users to share their virtual try-on experiences on social media and participate in online forums, fostering a sense of community and knowledge exchange. "WatchCraft AR" includes a community section for users to connect with fellow enthusiasts and professionals in the watchmaking field; 6) *Intrinsic Motivation*: both apps incorporate gamification elements to enhance intrinsic motivation. By completing challenges, quizzes, and repair simulations, visitors earn points, and badges, and unlock additional content, which encourages them to continue engaging with the App and deepening their understanding. 7) *Multiple Perspectives*: both apps

present information from multiple perspectives. "Timepiece Explorer" provides comprehensive descriptions and historical context for each watch, offering different angles of understanding luxury timepieces. "WatchCraft AR" showcases the strengths, weaknesses, and opportunities of specific watchmaking techniques, providing a well-rounded view of the craft. In conclusion, both "Timepiece Explorer" and "WatchCraft AR" effectively apply constructivist principles in their design and content. By incorporating interactive, authentic, and collaborative elements, they transform the museum visit into an engaging and educational journey, encouraging visitors to construct their knowledge and appreciation for luxury watches and watchmaking.

Considering the four categories proposed by Hein, namely *acquisition*, *inquiry*, *participation*, and *collaboration*, and taking into account the principle of constructivism, which envisions learning through the active creation of meaning and knowledge, it becomes evident that museums play a crucial role in facilitating educational experiences that go beyond passive observation. In line with this perspective, augmented reality emerges as a powerful tool for integrating information and digital objects into the physical environment of a museum, thereby creating a multichannel experience for visitors. Augmented reality enhances the traditional museum visit by overlaying digital content onto real-world exhibits, enabling visitors to engage with artifacts in a dynamic and interactive manner. By providing additional layers of information, contextual details, and immersive storytelling, AR technology enriches the visitor's understanding and appreciation of the displayed objects, which should be more than a museum guide on a mobile device (Vainstein, Kuflik, Lanir, 2016). This interactive approach not only stimulates curiosity but also encourages active exploration, critical thinking, and deep engagement with the art and cultural artifacts. In the constructivist framework, scaffolding plays a vital role in facilitating learning experiences. Scaffolding refers to the support and guidance provided to learners to help them grasp new concepts, build upon existing knowledge, and develop higher-order thinking skills. Augmented reality in museums can serve as an effective scaffolding tool by providing contextual cues, prompts, and interactive elements that guide visitors through the learning process. Through carefully designed AR experiences, museums can scaffold visitors' understanding by presenting information in a structured and accessible manner, gradually increasing the complexity of the content, and offering opportunities for reflection and consolidation of knowledge. Looking toward the future, the potential for mentally managed sensors opens up intriguing possibilities for further enhancing the museum experience. As technology continues to advance, there may come a time when visitors can interact

with exhibits using their thoughts. This groundbreaking development would revolutionize the way we engage with museum collections, allowing for direct and intuitive interactions. By harnessing brain-computer interfaces, visitors could manipulate virtual representations of objects or navigate virtual environments related to the exhibits, offering a unique and personalized journey through art and culture. The integration of emerging technologies, such as augmented reality, holds great promise for museums in terms of providing captivating and educational experiences. By embracing these technologies and incorporating scaffolding strategies, museums can transcend the traditional boundaries of “space and time”, creating immersive and accessible learning environments that cater to diverse audiences. Moreover, these advancements bridge the gap between the physical and digital realms, blurring the distinction between tangible artifacts and virtual information, and fostering a deeper connection between visitors and the cultural heritage they encounter. In conclusion, by “leveraging” augmented reality, exploring the potential of mentally managed sensors, and incorporating scaffolding strategies, museums have the opportunity to offer visitors a truly transformative and engaging experience. These technological advancements provide a gateway to unlocking the educational potential of museums, enabling visitors to delve into the rich narratives of art and culture through interactive, multi-sensory, and personalized encounters. By embracing these innovations, museums can position themselves as dynamic educational institutions that not only inspire and educate but also scaffold visitors' learning processes, supporting them in constructing meaning and knowledge in a meaningful and memorable way.

7. From Idea to Reality: A Step-by-Step Guide for Augmented Reality and Virtual Reality Projects in Museum Education

Starting from what is described in this article, the researchers of the LabH afferent to the Department of Philosophical Humanities and Education of the University of Salerno (labh.it/disuff) starting from the many previous experiences in the field of museum education through augmented reality and virtual reality could proceed, if of interest to museum institutions, to proceed as follows to arrive at a finished product:

1. Design: Researchers redefine project goals and requirements with the museum director.
2. Prototyping: Low-fidelity or interactive mockups are created to validate the design.

3. Coding: The design specifications are translated into computer code using the chosen programming language.
4. Testing Phase: Functional and integration testing is conducted to ensure proper software functionality.
5. User Testing: Involving end-users to evaluate usability and user experience.
6. Iteration Cycle: Continuous feedback collection and improvement process.
7. Final Implementation: Completing the project and preparing it for deployment.
8. Distribution to museum users.

Conclusions

In accordance with what has been described above, some operational proposals can be developed to improve the function of the museum as a place of learning and social inclusion. First, museums should adopt the constructivist museum concept, seeking to create interactive spaces and hands-on workshops that engage visitors in an active learning experience. This would allow visitors' creativity and critical thinking to be stimulated by providing opportunities for them to experience and interact with the exhibits. Second, museums should pay more attention to social inclusion, seeking to engage visitors of different ages, cultural backgrounds and educational levels. This can be done through the creation of specific educational programs aimed at disadvantaged groups of visitors or people with disabilities. Third, museums should seek to develop new technologies and sensory interfaces to enhance the experience of interacting with exhibits, so that visitors can interact with original works whenever possible, but also enjoy digital experiences that broaden the educational and enjoyment offerings. In brief, the museum is a constantly evolving place that must adapt to changes in society and the needs of visitors. By adopting the constructivist museum concept, promoting social inclusion, experimenting with new technologies, and specializing in specific themes, museums can become increasingly engaging and interesting places of learning and knowledge. In this context, the concept of *Imaginary Virtual Worlds* assumes a central role, offering us the freedom to access increasingly complex and sophisticated virtual worlds created by the intersection of art and science. Such worlds are thus presented as a modern Museum of Culture, where Virtual Reality takes us on a journey of discovery through imagination and knowledge, allowing us

to interact with the exhibits in an increasingly natural and engaging way; these worlds become a fundamental tool for cultural dissemination, offering us the chance to explore places and works of art. In conclusion, the integration of an interactive video game system within a constructivist museum setting emerges as a promising avenue for fostering transformative experiences in both visitors and environments. By harnessing the educational act as an *agent of change*, this innovative approach offers diverse and dynamic learning opportunities, capable of engaging and empowering individuals within the museum context. Through interactive gameplay, visitors can actively construct knowledge, participate in immersive learning experiences, and develop a deeper understanding of the exhibited content. Simultaneously, the museum environment itself undergoes a transformation, becoming a dynamic and adaptive platform that responds to the needs and interests of its visitors. Such a symbiotic relationship between the educational act and the interactive video game system holds the potential to revolutionize the educational landscape within museums, paving the way for enriched and multifaceted educational experiences. As the educational paradigm continues to evolve, embracing this interactive and constructivist approach can serve as a cornerstone for museums seeking to offer varied experiences that foster education and meaningful engagement in the digital age.

References

Aiello, P., Di Tore, S., Pace, E. M., & Sibilio, M. (2016). *Insegnare a leggere la mente. La realizzazione di un edugame per lo sviluppo delle abilità sociali in soggetti con Disturbo dello Spettro Autistico*. Italian Journal Of Educational Research, 17, 87-104.

Ariano, G. (2019). *Dalla V/verità al TU. La sua invisibile presenza*. Casoria: Edizioni Sipintegrazione.

Berthoz, A. (2015). *La vicarianza. Il nostro cervello creatore di mondi*. Torino: Codice.

Bruner, J. (1966). *Il processo educativo. Dopo Dewey*. Roma: Armando Editore.

Bruner, J. (1982). *Verso una teoria dell'istruzione*. Roma: Armando Editore.

Bruner, J. & Haste, H. (1987). *Making sense: The child's construction of the world*. New York: Methuen.

Caponetto, I., Earp, J., & Ott, M. (2014). *Gamification and education: A literature review*. In European Conference on Games Based Learning (Vol. 1, p. 50). Academic Conferences International Limited.

D'Alonzo, L. (2015). *Didattica speciale per l'inclusione*. Brescia: La Scuola.

Gentili, G. (2016). *Prove di competenza, compiti di realtà e rubriche di valutazi*one. Trento: Erickson.

Gonulal, T., & Loewen, S. (2018). *Scaffolding technique*. The TESOL encyclopedia of English language teaching, 1-5.

Hamari, J., Koivisto, J., & Sarsa, H. (2014). *Does gamification work?--a literature review of empirical studies on gamification*. In 2014 47th Hawaii international conference on system sciences (pp. 3025-3034). Ieee.

Harris, B. A. (2006). *The Importance of Creating a "Sense of Community".* Journal of College Student Retention: Research, Theory & Practice, 8(1), 83–105. https://doi.org/10.2190/AMNM-2VKP-V6MH-D1GF Retrieved [August 12, 2023, 2023]

Hein, G. E. (1998). *Learning in the museum*. Oxon: Routledge.

Hein, G. E. (2000). *The constructivist museum*. Journal of Education, 180(1), 15-29.

Hein, G. E. (2001). *Constructivist learning theory*. In S. B. Merriam (Ed.), New directions for adult and continuing education (pp. 13-22). Jossey-Bass.

Hein, G. E. (2002). *Progressive museum practice: John Dewey and democracy*. Museum News, 81(6), 28-35.

Hein, G. E. (2006). *The museum in transition: A philosophical perspective*. In H. Silverman (Ed.), The museum as arena: Artists on institutional critique (pp. 31-40). University of Pennsylvania Press.

McKay, S., Van Schie, J. & Headley, S. (2008). *Embarking on an Educational Journey in Second Life*. In K. McFerrin, R. Weber, R. Carlsen & D. Willis (Eds.), Proceedings of SITE 2008--Society for Information Technology & Teacher Education International Conference (pp. 1762-1766). Las Vegas, Nevada, USA: Association for the Advancement of Computing in Education (AACE). Retrieved July 20, 2023 from https://www.learntechlib.org/primary/p/27450/ Retrieved [August 12, 2023, 2023]

Norman, D. A. (2004). *Emotional design. Perché amiamo (o odiamo) gli oggetti della vita quotidiana*. Milano: Apogeo.

Rivoltella, P. C. (2015). *Il digital education day e le dieci tesi di Rivoltella su scuola e tecnologie*. https://medium.com/il-digitale-e-la-scuola/il-digital-education-day-e-le-dieci-tesi-di-rivoltella-su-scuola-e-tecnologie-6f21e4daaf71 Retrieved [August 12, 2023, 2023]

Saleem, A. N., Noori, N. M., & Ozdamli, F. (2022). *Gamification applications in E-learning: A literature review*. Technology, Knowledge and Learning, 27(1), 139-159.

Searle, D. (1984). *Scaffolding: Who's building whose building?*. Language Arts, 61(5), 480-483.

Shanker, Stuart G. & Taylor, Talbot J. (2001). *The house that Bruner built*. In David Bakhurst & Stuart Shanker (eds.), Jerome Bruner: Language, Culture, Self. Sage Publications, 50-70.

Sibilio, M. (2020). *Interazione didattica*. Brescia: La Scuola.

Tessaro, F. (2014). *Compiti autentici o prove di realtà*?. Formazione & insegnamento, 12(3), 77-88.

Vainstein, N., Kuflik, T., & Lanir, J. (2016). *Towards using mobile, head-worn displays in cultural heritage: user requirements and a research agenda*. In Proceedings of the 21st international conference on intelligent user interfaces, 327-331.