The Museum Experience

Learning and Engagement through the Emergence of New Interactive Technologies in Art Museums

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Abstract

The premise of this paper focuses on how new innovative technologies are having an impact on learning and engagement within art museums. The paper provided three different case studies which all presented innovative interactive technologies. Two case studies from the ARTLENS gallery, one which analysed an interactive multi-touch display, and another which incorporates eye tracking technology. The last interactive is from the Lumin exhibit at the Detroit Institute of Arts which predominantly centered on augmented reality technology. Using the Contextual Model of Learning Framework by Falk and Dierking, in addition to other academic sources and theories, a qualitative analysis was conducted to see how learning and engagement is being initiated within these interactive technologies. All three case studies placed an importance on personalization and free-choice for each visitor. Although there were certain issues that are highlighted through the analysis of the case studies, overall the interactive exhibits all have the potential to provide a new method of engagement and learning within the art museum space.

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1. Introduction

Within the last few decades, the focus of museums and alternative education research has changed. The target is now on how and what visitors learn in a museum setting. There are studies that have indicated that "over 80% of learning is not done in a traditional education setting" (Hoholt, 2017). This speaks volumes to the importance of informal learning institutions and their effect on individuals and their learning acquisition. However instead of being a competitor to formal education, museums help provide an additional resource for both formal and informal learning (McEwan, 2006). Within the last decade, museums have been looking into interactive exhibits to help them in the learning and engagement process of visitors.

The topic of digitized works through new and novel technologies is now being referenced quite often within newspapers, journals, and through conference showcases. There has been a rise of initiatives within museums and specifically art museums. This rise in interactive technologies has also caught the attention of the media. There is now a lot of media coverage that is focusing in on the rise of interactivity within the museums. Some of these sources of the coverage has come from CNN, Los Angeles Times, New York times, as well as many more (Keramidas 2013). Additionally, there are a lot of state of the art reports that are now covering interactivity in museum settings. An example of this comes from the Association of Art Museum Director's "Next Practices" series, which has spoken about the new innovative initiatives that have come to the forefront. The report has submissions from 40 art museums curators and leaders on the different implementations of interactive technologies within museums spaces. Topics spanning from in-house mobile apps to gallery interpretations. The series of reports are able to shine a light on the importance art directors place on the ever increasing role of interactive technologies within art museums. (AAMD, 2015).

Museums been a significant source of learning when it comes to public education outside of formal schooling (Liu, 2013). Museums provide resources for all curriculum areas, complement education when pupils are off curriculum, stimulate pupils and those that find learning difficult, and are sites of enhanced achievement, going beyond what learners think they can do (Hooper-Greenhill, 2007). With the advancements to digital technology, interactive exhibits have become commonplace amongst museum spaces. The word "digital" in this context is used to describe online and electronic software which assist visitors in their communication amongst themselves and the museum. The digital technologies that have

become more widespread in recent years include: virtual reality (VR), augmented reality (AR), multisensory, and other multimedia technologies.

In previous years, researchers placed a larger importance on topics such as average number of visitors or the amount of time that has been spent at a museum. But with implementation of interactive technologies, the focus has shifted to looking more at statistics that are more emphasised in our modern day. The focus is now more on how people make sense of exhibits as well as the overall experience the visitor is presented with (Hornecker, Clarke, 2013). For an art museum to successfully implement any form of interactivity presents unique challenges that are not usually found within other types of museums. Although there has been a rise in digitized and interactive exhibitions in museums worldwide, typically in an art museum today, the implementation has been slightly slower in the progress. The experience that one has at an art museum can at times be a static one that is strictly visual. This is even more prominent with traditional art museums rather than contemporary art museums. Implementation has been more problematic for art museums compared to other types of museums such as history or science museums. In history and science museums, it is viewed as more acceptable to implement interactivity in the museum spaces as the communication has the objective of creating efficient and engaging learning experiences. In this context, the installations themselves become the main object of the museum setting. When you view this from the perspective of an art museum setting, the art itself is what the main source of the visitor experience is derived from, hence the reason why it is more problematic to implement interactivity in art museums (Kortbek, Gronbæk, 2008). So due to this, what we will see from certain art exhibits is a very minimal presentation attached to the artworks itself which may come in the form of a catalogue, guide presenters, signs, etc.

McLean defines interactive exhibits as "those in which visitors can conduct activities, gather evidence, select options, form conclusions, test skills, provide input, and actually alter a situation based on input" (Mclean, 1993). Interactivity at its essence is being able to take action. In a museum setting the visitor has a reciprocal relationship with the museum where the exhibit and the viewer are reacting to one another. Learning and engagement have been recognized as being very crucial to the effectiveness of an interactivity within museums. The problem is that the relationship between these two dynamics need to be further researched as these two particular notions are not fully understood yet especially when you consider that

there are new and emerging technologies that have yet to have a lot of research conducted on them.

Interactive exhibits within museums spaces are quite commonplace now and they are generally considered to be useful in regards to learning and engagement [Gammon, 2003]. Yet, determining how learning and engagement occur and the direct relation they have to one another is still an area of research that is not heavily looked into. Visitors may spend extensive amounts of time interacting with exhibits without properly looking into the information that is displayed. Consequently, the interactive exhibit may be seen as engaging the user, but it may not be supporting the visitors in their learning process. It is also a possibility learning might be occurring by the visitors in spite of only spending minimal amounts of time interacting with the interactive exhibit while possibly being also being involved in various other activities at the same time.[Haywood, Cairns 2005].

There have been case studies and research completed on emergent interactive technology in exhibits, an issue is that a large amount of this research has not been studied within the art museum space(Harrison, 2011). In this paper, an investigation will be conducted on whether augmented reality (AR), multisensory, multimedia exhibits allow for proper visitor engagement and learning within the respective environment. For example, it is possible that visitors spend long durations of time interacting with exhibits without reading the presented information. Therefore while the exhibit may be engaging, it may not encourage visitors to learn. Furthermore, it is possible that visitors may learn from an interactive exhibit despite spending only a short duration of time interacting with it and simultaneously being involved in other activities. The modes of technology that will be presented within the case studies are all relatively new, thus, limited in the field of research that has been conducted. Through the employment of the contextual model of learning framework (Falk & Dierking, 2000), and other various literature sources. The study will attempt to gain a better insight on how these new digital technologies are being implemented in art museums and how they are affecting learning and engagement. The Contextual Model of Learning is a theoretical framework that is based on personal context, sociocultural context, and physical context, all three are vital in the influence that it has on visitor learning in museum settings. The framework will be discussed in detail in the following section.

A question that is confronted often is how art should be experienced? According to John Dewey, the experience should not be about the objects, but rather about the emotions and feelings that an object can evoke. “A true work of art is a refined and intensified form of

experience." He argues that the structure created by art museums has created a disconnect between art and people, essentially removing art from people's daily lives.

He suggests that the museums experience should be able to "formulate exhibitions that lead to inquiry and that guide visitors to apply the results of such inquiry to life situation" (Hein, Dewey, 2010).

For museums and other cultural heritage sites, a new era has arrived especially for contemporary art museums and the methods that they use to create their digital artworks. The status quo within the art world had placed a monopoly on curated, publicly accessible art. With the advances with interactive technologies, art museums and museums in general are now able to reconstruct the previous ideologies and systems that have been in place in exhibitions, and to re-imagine the way we can potentially present information and artwork to visitors in free choice learning environments such as an art museum.

This investigation into engagement within an interactive museum space will be conducted through the use of three case studies. The case studies will present different types of interactive museums each with varying modes of technology that are presenting unique experiences, distinctly different from one another. The first exhibit that will be part of the case study is the Gallery One exhibit in the Cleveland Museum of Art(CMA). The Cleveland Museum of Art has a dedicated section specialized for interactive exhibits called the ArtLens Studio. The second case study will also be an exhibit from the ArtLens Studio. The third case study is derived from the Lumin Exhibit at the Detroit Institute of Arts (DIA).

2. Literature Search

The entirety of the information and sources in this paper were found primarily through the use of Google Scholar, Trinity college website database, as well as other external sources (conference literature, discussion papers, and government policies). However, the case studies that are presented in this paper cover certain interactive technologies that have limited research on them. Therefore, some references within this academic paper are derived from respected websites and have been cross referenced to ensure the information that is given is correct. Analysis of the case studies are based on previous theories and frameworks that will be further detailed in the following section.

There were several methods employed for the analysis of the case studies. The methods included are: textual analysis of brochures, the personal website of each museums, pamphlets, postcards, as well as 3rd party online resources (images, videos, forums)

- Keywords that were used for literature sources include: interactivity, education, informal learning, personalization, engagement, constructivism, contextual model of learning, free-choice learning

2.1 Literature Review

The literature review will be outlining the different results that have been shown through previous research into personalization and engagement within interactive art museums. This section will give the readers an opportunity to be able to get a sense of how museums are engaging their visitors with their artefacts. The section will then further get into the existing types of interactivity that are currently present in contemporary art museums and what research is currently saying about the interactive technologies that we will be investigating.

In recent years with the surge of interactive exhibits, art museums have really taken in strong step in implementing new and novel technologies into their exhibit spaces. The use of technology in engaging the viewers has taken a big leap and has received strong attention. 'Bloomberg Connects' is one initiative that has come to the forefront of the integration of technology in art museums. Bloomberg Connects provides funding to cultural institutions to enhance the experience for the visitor as well as increasing the opportunities to be exposed to culture through new methods of technology. Cooper Hewitt Smithsonian Design Museum has been one recipient of this initiative. In general, technology is seen as being indispensable to the art museums and organizations, as seen by a recent Pew Charitable Trust survey of 1,256 arts organizations, which found that 78% of the organizations felt that technologies were "very important" for increasing audience engagement. And while art museums are progressively shifting the dynamics of art museums from a static one way style of communication to more of a model that centers around the visitor, it's crucial to find the right balance between the needs of the visitor and what museums curators want to display.

Integrative technologies have been coming to art museums through different paths. One way is through the creation of an online identity. The research done through the Pew survey

discovered that nearly 99% of all museums now have an online website. In addition to this, 97% of museums also have a presence within social media through platforms such as Instagram and YouTube and many others (Pew Research, 2013). Previous studies have also shown that visitors value the presence of a website, but in addition they also demand online, "user friendly" access to the collection of art that is available. (Moreno, Dywan, 2005). For visitors to have access to art collections online, research has demonstrated that it plays an important role in creating value for the visitor. With this in mind, in order to provide access the general public, museums are now creating online collections.

Institutions have made very large strides in keeping up with the modes of interactivity within the last 20 years. One prime example of that is with the Metropolitan Museum of Art, which has a dedicated staff of over 70 individuals in its digital department. Furthermore, a chart survey from Pew Charitable surveyed over 1,256 art organizations, and found out that "78% felt that technologies were "very important" for increasing audience engagement"(Pew Research, 2013).

In addition to adding an online presence, museums have also been implementing interactive technology into their museums spaces. For example, museums are now implementing mobile applications, tablet stations, and other various interactive elements. These have all been presented into the museum setting to support stronger visitor engagement. A lot of the research that we have currently centers around science exhibits and museums. Nevertheless, the research indicates that technological integrations in museums certainly does create interest amongst visitors as well as being able to hold the attention of visitors(Sandifer, 2003).

Katja Kwastek, a researcher from Harvard University has been quoted as saying "Interactive art places the action of the recipient at the heart of its aesthetics. It is the recipient's activity that gives form and presence to the interactive artwork, and the recipient's activity is also the primary source of his aesthetic experience" Contextualizing the goals of the artist and curator is also quite important. The artwork can be seen as the artist's 'reception proposition to be experienced in the here and now.' Works of dynamic-interactive character are those whose art object contains 'internal mechanism that enables it to change or it be modified. The human 'viewer' also has an active role in influencing the changes in the art object.' (Kwastek, 2017) .

In terms of interactive exhibits, Falk & Dierking (2000) define the process of learning by how well the visitors of a museum is able to understand the content on display. An example that we can give for this could be as such: A visitor is participating with an art exhibit that

has multiple different post-impressionist art on display with each one highlighting the different techniques used that allow it to be termed post-impressionist. Now if the visitor can subsequently be able to note the different techniques used, then learning can be said to have occurred. Within the last 3 decades, the constructivist theory to learning has been the method used in conducting our teachings. This style has been implemented in multiple different areas of teaching, particularly within the museum setting. In recent years there has been a growing consensus among museum researchers that visitor experience can be adequately described in terms of meaning making (Falk, Dierking, 2000). Meaning making is the process of a how an individual is able to construe, understand and make sense of their environment. Through meaning making an individual is reordering information which they have in their minds and are creating more complex, informative and more nuanced systems. Meaning making is a direct component of the constructivist teaching view.

A conceptual framework called the Activity Theory has also been used quite commonly used with interaction design. The theory originated from Russian psychology in the 1900's. It has also been widely used and accepted within learning and development. Considering that this theory is quite compatible with learning and interactions design. It is a very suitable framework to be used in research with technological implementations within museums settings. The basic principles of activity theory are driven by the guidelines that human activities are: " (a)object-oriented, motivated by objectively existing objects, (b) hierarchically structured; spanning a wide range of processes and phenomena, from motivation to skills, (c) mediated by socially developed artefacts, (d) involving continuous transformation between internal and externally distributed processes, as well as individual and socially distributed ones, and (e) constantly developing" (Kaptelenin, Nardi, 2006). When applying these propositions with digital technologies in museum settings is that one of the main targets for the implementation of technology in museums should be for bridging activity contexts. Kaptelinin provides 8 main areas that the activity theory covers:

1. The needs, hopes and fears, goals, social relations, and professional backgrounds of museum visitors
2. The diversity of tools and other mediating means available to visitors
3. Museum artefacts directly experienced by a visitor, as well as other artefacts and the whole physical and social setting of the museum
4. Development of visitors' activities over time, taking into account what happens before and after a visit

5. Support of visitors' understanding of who was using the museum artefact in the past
6. Support of visitors' understanding of why, for what reasons, the museum artefact in question was used in the past
7. Support of visitors' understanding of how the artefact in question was used or produced in the past
8. Support of visitors' understanding of unfolding temporal and logical sequences, narratives of using the artefact in question in the past

(Kaptelinin, Nardi, 2006) .

The activity theory presents several commonalities with the Contextual Model of Learning framework. An emphasis is placed on the visitor's personal context within both frameworks. Taking in the importance of creating an environment where diverse groups of people will be able to sufficiently learn and engage through the exhibitions.

The general nature of museum experiences and the process of learning goes through the notion of meaning making. This concept highlights the importance of the visitor's imagination, reflection, and interpretation which take place during, and after a visit. Meaning making within museum settings have been under heavy research and analysis within multiple empirical studies and conceptual research. These studies have constructed a group of principles that are recommended to be best in order to support the concept of meaning making. These principles are "ensuring engagement, supporting diversities of interests, helping people reveal hidden content, and integrating museum visits into larger-scale events (Diamantopoulou, Insulander and Lindstrand, 2012).

Yet, at times it's not clear how the information regarding meaning making can help curators and designers in the deployment of technologies within museums. Engagement in interactive technologies cannot be directly created, the creation of an interactive space that aligns with the designer's desired experience for the visitor is one that is difficult to construct. The technology itself is not the whole solution for engagement of visitors. It can be seen as a precondition for the engagement of the visitor by supporting the visitors' exploration, reflection, imagination, and emotional attachment (Kaptelinin, 2011). To be able to reach this goal, curators need to have a more comprehensive understanding of experience of the visitor and the dynamics that are in play.

Whether the visitors are engaged with the technology will entirely depend on the methodology of the works and other various factors. If visitors are engaged, we have to

determine if the engagement is more so towards the technology and diversion to the artworks or whether if they do help in being a complementary tool for the artworks. These are question that we will further investigate within this paper.

We are constantly updating and advancing with our usage of technology in museum spaces. There are now countless amounts of exhibits that are now using technology that is relatively new to the market. Such examples are through virtual reality, augmented reality technology as well as different variations of multimedia technology. In regards to ubiquitous computing and interactive technologies, research has shown indication that it is quite effective in being able to create meaning and engagement for visitors in the museum settings. Although most of the research that has been conducted has been within history and science museums (Hall & Bannon, 2006). Certain questions such environment and visitor disruption should be kept in mind.

In the constructivist approach to learning, the process of learning in museums is not just about the teaching process of the museum, you have to take into account what the visitors and is able to experience from their own museum experience. The visitors create their experience and meaning from their personal values. Subsequently, the museum personnel should provide environments and experiences where the visitors can further investigate, solidify and confirm their knowledge (Adams, 2007).

One framework of learning that has been very influential within museum settings is the contextual model of leaning which has been proposed by Falk and Dierking. Learning within this framework can be conceptualized as a context driven effort to make meaning, this in turn will help you survive and do well within your world. It can be seen as a continuous dialogue that goes on between the individual and their physical and socio-cultural environment. This framework presents this context driven dialogue as the by-product of interactions that an individual has between their personal, socio-cultural, and physical contexts that occurs over time (Falk and Dierking, 2000).

The CML framework is divided into three sections:

1. Personal context

Learning will occur with motivational and emotional cues. Learning is done by engaging with a user's personal interest. New knowledge is created through the foundation of previous experience and knowledge. So from the personal context perspective, when something is learned we expect it to be paralleled to an individual's motivations and their

expectations. Allowing visitors to have choice and control and be able to choose what they deem as interesting will ultimately optimize their ability to learn.

2. Socio-cultural Context

Learning is conducted through individual and group settings. Visitors that are in groups will utilize each other as tools for reinforcing beliefs and meaning making. Also, people will visit museums for various different reasons and they come from diverse backgrounds. Therefore, the activities that they seek out will vary from visitor to visitor and will ultimately affect their museum experience.

3. Physical Context

Learning is more likely to be initiated when a visitor is comfortable with their surroundings. The awareness of environment is also a vital aspect of learning, the design of the specific exhibit that they are interacting with will have an important impact on their learning. Additional, reinforcing experiences outside of the museum context can also have an influence on what is learned from a museum experience.
(Kisiel, 2003).

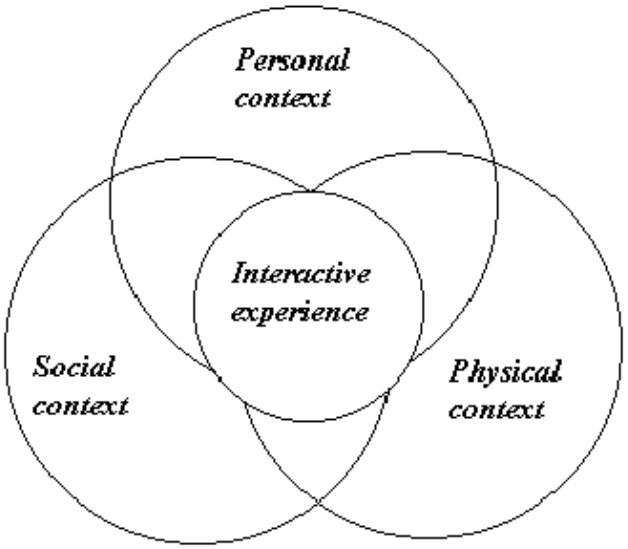

FIGURE 1. Contextual Model of Learning diagram. Retrieved May 10th, 2018 from: http://www.soendagaften.dk/arkiv/1998/980111.html

2.2 Personalization in Museum Settings

It is important to note that personalization is a key factor in regards to visitor engagement. With each visitor that visits a museum, there are unique and personal sociocultural contexts that are attached to them, with makes the meaning making personalization process unique to each individual. This has yet to have been something that is deeply investigated and presents a good opportunity to be able to reach for a deeper insight into the different medias and whether or not they present experiences that are suited for our mixed cultural world that sees diverse people coming to visit interactive art museums.

The influential strategies of postmodernism mesh together well with the technological and social changes that have occurred. In return, this has been changing the paradigms of communication within art museums (Silverman, 1995). A theory that is at the forefront is the constructivism theory. Designers and curators no longer keep the status quo when it comes to the learning process and engagement of visitors, it requires curators to go beyond the marketing strategy and to start thinking more comprehensively about their construction of the interactivity that is implemented with artworks. (Hooper-Greenhill, 2000). The decision to visit a museum or not, and whether the experience is an enjoyable one is mainly determined

through the experience that they are receiving, and as stated, experiences will be greatly varied between each individual depending on cultural and social contexts (Hooper-Greenhill, 2000).

Personalization and narration has shown to hold a vital responsibility in learning in informal settings. (Haywood, Cairns, 2005) studied multimedia learning environments such as CD-ROMS and stated that narration is linked to learning by making the presented information personal. Additionally, Falk & Dierking [2000] also stated that the creation of personal context will lead to deeper learning by giving the opportunity to individuals to be able to attach meaning to the information that is presented.

2.3 Problem Formulation

So with the case studies that will be presented, it's important to discuss how these emerging technologies that are now prevalent within interactive exhibits take into account learning and engagement within their works. The main objectives of this paper will ultimately be about how these new methods of interactive technology are being successfully integrated into the traditional museum experience for visitors, and the impact it has in terms of engagement and more specifically, the learning potential of visitors with the integration of these technologies. The goal is to essentially try to figure out the impact of the interactive technologies. The manner in which interactive technologies are provided must be carefully considered and thoughtfully carried out, as the easy assumptions that more interactivity is always better, and that interactivity for its own sake is a net positive, is not always accurate (Emmanuel, Morse, Hollis, 2016).

The large increase in digitized works also brings about questions regarding its impact on the experiences of the user. For example, it would be interesting to further seek out whether the implementation of original artwork through various forms such as sensor technologies, touch screen participatory exhibits and other various forms of engagement; whether these will vary in regards to the engagement and immersion of the visitor. Another potential problem that has arrived with the emergence of interactive technologies is the issue of isolation and the distraction of the visitor. An argument has been made by Heath and von Lehm that states that visitors often have a collaborative experience with exhibits when it comes to responses; they are occasions of joint action. The visitors assist one another in deciding whether or not

to participate in interacting with an exhibit, the meaning they attach to it, and the memories that they store in regards to it. As a joint union they navigate a common shared space and align their decisions and actions to create an emergent, adaptive definition of the situation (Heath and von Lehn 2003).

It is clear that we have reached a stage where the issue is no longer about whether it is suitable to use novel and new technologies within art museums but rather, what types of methods are used to make certain that the technology used to support the visitors experience will not overshadow the primary reason for the visit; which is the art. Particularly with screen based interactives, it often will end up interfering with the direct engagement of visitors with the exhibition and the place, at times isolating the visitor and diverting their attention from the real physical objects that are on display (Von Lehn & Heath, 2003). These concerns will be sought out through three separate case studies presented later in the paper. Overall, the objective in studying interactive technologies in art museum spaces is to offer practical suggestions for museums to be able to fully take advantage of the potential of digital technology and to offer differing avenues in regards to visitor engagement and subsequently the learning that will occur from that.

3. Methods & Methodology

This paper is based on previous research that has been previously conducted in the field of learning and engagement in interactive museums and educational institutions. The paper will be further looking into the different methods of interactivity that are present through our three case studies, determining how each example takes into account learning and engagement within their respective work. The main goal is to bring about a multifaceted perspective on the museums engagement of visitors. The content of the analysis will be based previous literature, current projects within the sector as well as learning frameworks that have been discussed in the literature review. The research into the three case studies are considered very crucial to the completion of the dissertation; providing vital qualitative information. The main hypothesis within the research paper will be based mostly off the framework that has been set out for our case studies. Additionally other theories and information derived from the literature review will also be used in the analysis. In return, this qualitative research through our framework will help us bridge the gap that is currently seen between the available academic journals and the current state of the art within the field. Ultimately helping to

improve clarification and insight into engagement and learning in interactive technologies in museum settings.

The three case studies all present interactivity in novel ways which are distinctly different than one another. The variation between the 3 case studies is important so that it creates a more comprehensive overview of the current technologies that are present within museums and cultural heritage sites. As stated previously, although there are large amounts of research on interactive technologies in museums; there is not an extensive amount of research on the newer technologies that have emerged within the last few years.

The analysis of the case studies will primarily based on the Contextual Model of Learning Framework(CML) by John Falk and Dierking. Although there are several models and theories that have been covered within the literature review, the CML framework is most suitable for our case study as it is well constructed to match a qualitative study. The framework has also been used extensively in museum research and practice (Marianne, 2015).

(TABLE 1) Exhibits Analyzed

Museum Attendance	Location	*Annual*
Artlens Studio, Cleveland Museum of Art	Cleveland, Ohio	707,000
Lumin Exhibit, Detroit Institute of Arts	Detroit, Michigan	677, 500

3.1 Case Studies

The three case studies will first be presented with a brief background and history for each. Then using the theories and frameworks discussed in the literature review, an analysis will be conducted on the interactivity implemented and their relation to engagement and learning. The analysis will be reliant on the Contextual Model of Learning Framework by Falk and Dierking and the three contexts that are presented within the framework: Personal, Socio-cultural, Physical. Other sources within the field of learning and engagement will also be presented. Following each analysis, there will be a suggestions and an overview section on how the case studies can potentially improve the learning and engagement process for each of the exhibits. Two of the case studies are derived from an exhibition at the ARTLENS gallery, while the third is derived from the Lumin Exhibit at the Detroit Art Institute.

History & Description

ARTLENS Gallery, Cleveland Museum of Art

The ARTLENS gallery was initially called the Gallery One exhibit but then relaunched itself in March of 2017. The initial exhibit, Gallery One, opened in January 2013. ARTLENS Gallery is a section of the museum that is dedicated to bringing new and innovative technologies into their space, blending art, technology and interpretation. The opening of Gallery One in 2013, boosted the individual attendance at the museum by an increase of 31%, the attendance of families also increased by 29%. Gallery One was featured through various museum and web-conferences and has been utilized as a case study through multiple publications, as well as for museums all around the world. Through the last five years, almost every major museum has sent a director for visits to the space (CMA, 2017). The museum is set up in a way so the ARTLENS gallery is the starting point for the museum visitor and it is intended this way to help them become quickly familiarized with the vast array of artefacts that are digitized with the interactive exhibits. The ARTLENS is made up of two rooms. The first room of the gallery is placed right near the main entrance of the museum. Within the first room, there are a total of six exhibits, while the second room has a total of ten exhibits. All exhibits are organized by varying themes such as symbols, gesture + emotion, and purpose. Each interactive within the ARTLENS attempts to connect with the visitor through various

types of engagement strategies. Some of these exhibits will allow visitor to create their own works of art, others will use sensor technologies to track a visitor's gaze, others will use gestural recognition software, as well as many other more methods of technological innovation. In total there are 16 innovative interactives within the gallery. In this paper, the focus of the analysis will be on two of the exhibits within the gallery. These two exhibits have implemented interactive technologies that are distinct from one another, as well as being new innovative technologies. One of the exhibits is the Gaze Tracker exhibit and the other is the ARTLENS wall. Both will seek out what the main focus of this academic paper is, which is how these interactive technologies compliment visitors in their engagement and learning process.

The guiding literature and resources in the implementation of the ARTLENS Gallery comes from several various sources. According to project lead director of the ARTLENS gallery Jane Alexander. She describes that the research that was influential within the implementation of the gallery include The Dallas Museum of Art. They have published a research paper called the Ignite the Power of Art. This exploration was a key source for being able to gain a further understanding of visitor engagement and the dynamics behind engagement (Pitman & Hairy). Also, John Falk's "*Identity and the Museum Visitor Experience (2009)"* is one of the main sources for the motivation. Within this literature Falk explains that visitors' motivation is a key concept when it comes to understanding your audience, rather than being overly focused on the demographics and statistics that are presented in your institution, the needs and the personalization of interactives should be prioritized. (Falk, 2009).

4. Analysis

ARTLENS Wall Exhibit & Artlens Application

The first case study that will be looked into is the ARTLENS wall exhibit within the ARTLENS GALLERY. A special mention will be given to the Artlens application as well. The application is a complimentary device to the exhibits within the whole ARTLENS gallery. The interactive wall is one of the main attractions from the collection of exhibits that are present at the gallery. The ARTLENS wall is a 40ft wide by 5ft high interactive wall which displays all the works of art from the permanent collection currently on view in the

gallery, all in actual time. In total there is between 4,200 and 4,500 digitized artworks at any given time. Additionally, it also allows up to 20 visitors to use the wall simultaneously, allowing up to 20 separate interfaces to be displayed at once. There is also a thematic grouping of the artworks designed by the staff of the Cleveland Museum of Art. The grouping highlights various themes throughout art history and are looped in a 40 second cycles which go through all the various collections in the museum. The wall is created by 150 Christie Micro Tiles and display more than 23 million pixels. Through a cycle of 10 minutes, an application content management system updates the wall with varying images in the collection, metadata, and also the varying "favorited" playlists that visitors have created, and displaying the visitor created lists on the screen. The software for this was created through open Frameworks and runs on two windows 7 workstations that are supported by four Linux servers, these process the video across the entirety of the wall. High resolution digital camera that range from 48 to 192 megapixels were used for the photography of the CMA collection. These are all high quality photographs that allow the visitor to be able to experience a realistic perspective on the digitized artworks.(CMA, 2017).

As previously stated one of the concerns that has been emerging with interactive technologies is the issue of isolation of the visitor and having it distract their attention from actual social aspects of learning. Research by Heath and vom Lehn has argued that social aspect of the museum experience has been ignored by designers and curators (Heath and vom Lehn 2004). Human beings are naturally inclined to be social creatures and we are all products of our culture as well as social relationships (Ogbu, 1995) When individuals are in a free choice learning environment exhibits should be set up to allow visitors to engage with one another. Creating an environment where collaboration and sharing is possible will help solidify the learning and engagement process. Given this, museums should prioritize interactive exhibitions to be socioculturally situated. In regards to the ARTLENS wall, it is clear that the set-up of this exhibit encourages viewers to be able to engage with one another in a very open and accessible fashion. It is one large screen that is capable of allowing up to 20 visitors to interact simultaneously. It also encourages collaboration and sharing through the options that the wall provides. For example, you have the ability to create your own personalized favourites folder; the creation of personalized folders in an open and accessible environment where up to twenty visitors can be operating at once. Once created the folder can then be easily retrieved digitally by other visitors that are using the ARTLENS wall exhibit. This is helpful in creating an accessible and collaborative environment.

One of the features that the ARTLENS wall possesses, is the ability to save your favourite artefacts on display into your own iPhone or iPad through the museum app called the ArtLens application. It gives the visitor the option to create different folders and categories within the app such as a creating a favorites collection, your own personal tour, and the ability to get more information about the artworks that they have downloaded into their app. The ArtLens application is in sync with all the interactives within the gallery. The application can be downloaded onto your Apple device. If a customer does not possess an Apple device the museum will provide the visitor with one. All the artworks that you learn about while interacting with gameplay interactives, you can choose to save them within your application. Photos that are taken during gameplay interactives will also be saved to your application as well. The saved digital artworks are all marked within the digital map on the application and they act as a wayfinding system that will guide you to where each respective artefact is within the museum itself. By syncing and saving the artworks into the application, the visitors are then encouraged to further their inquiry with the artworks and to be able to continue the learning and museum journey.

An additional benefit of having an interactive such as the ArtLens wall and ArtLens app is that it gives the visitor the ability to make their museum visit more efficient. Given that the museum possesses an extremely large collection and is large in its physical dimensions, the visit can be overwhelming for some. The features of the wall will allow visitors to be able to efficiently choose the artworks that catches their interest, and then immediately save it into their application and use the wayfinder system to be able to view the artworks in the physical environment. It is an efficient system that can be helpful in allowing visitors to create more organized museum visits.

There is documented research that indicates that learning is not an instantaneous process, but rather a cumulative process of acquisitions and consolidation (Anderson, 1999). The usage of the application is useful in helping visitors to be able to retrieve information that they accessed within the museum setting in any given time or environment. It creates a reinforcing experience outside of the museum grounds, where a visitor can further explore concepts and artworks. This has also been a concept that is emphasized within the physical context layer of the CML framework.

Although large amounts of research have been leaning on the indication that museums are being enhanced by the integration of interactive technologies, it may not be seen as a useful commodity for children within a museum space. The reason for this is because it may be problematic for them to see past the physical interaction and therefore have difficulty in being

able to sufficiently acquire and engage with the interactive technologies. Andy King, the curator of industrial and maritime history at the Bristol museum service, states that visitors of the museum especially the children, "seem to be only interested in twiddling buttons of interactive works"(Ciolfi, Cooke, 2005).For younger children engaging with the interactive wall, this may also be seen as issue. Although the Gallery has stated that the exhibit is created for people of all ages, those that are younger may have difficult in properly engaging with the interactive in the way that it is intended to. Due to all the interaction being done through a touch screen, and its ability to retrieve and display artworks through categories and groupings, it may come off as an overwhelming interface for younger audiences.

Falk & Dierking [2000] have conducted research on how museums can provide a structure that helps create better learning environments. They have stated that "the creation of the personal context will lead to deeper learning by giving the opportunity to individuals to be able to attach meaning to the information that is presented". This exchange of systems within the ARTLENS wall and the mobile app has created a process that prioritizes personalization for the visitor. The wall has created an interactive that is targeting a large diverse audience, but also focusing on the personalization process for each individual that is engaged with the wall. It's a system where interacting with digital technology will consequently make you more motivated to go see the actual art itself through the personalized favorites list that they have created. This interactive provides a free-choice learning environment which allows a variety of opportunities and possibilities to occur.

Evaluating the ArtLens wall through the socio-cultural context of the CML model, there are a few concerns that do arise. Overall, the exhibit does a good job of creating a collaborative environment which places an importance on social groups and group participation. The integration of the ARTLENS wall with the ArtLens application, can potentially cause visitors to be strongly immersed with the technologies and forgo the communication amongst one another. The wall interactive itself helps with social collaboration and emphasizes group communication, but in regards to the ArtLens wayfinder feature, it may be immersing the visitor too much into their phone. The socio-cultural context places an emphasis on the idea that meaning making is developed through the mixed dynamics present with visitors, the visitor collaboration amongst one another, and the tools and activities that the mediator provides. Mclean who is a education researcher has also stated the importance of collaboration and communication amongst visitors. "Exhibitions provide a safe and interesting environment which bring people together, and the presence of people- whether they are visitors or staff transforms a constructed exhibition setting into a

dynamic public space. Staff explainers, docents, storytellers, artists, and actors enliven exhibitions, create context, and encourage people to interact with each other and with the exhibits. Even without staff, an exhibition designed to encourage face-to-face interaction and dialogue among visitors-often strangers-is arguably one of the most vital contributions museums can make to the social dynamics of our times" (Mclean, 1999).

Overview and Suggestions

Overall, the ArtLens wall has done an effective job in creating an interactive which is catered towards people with a multitude of diverse backgrounds. This is done through the variety that they provide in terms of artworks and the multiple features they provide for the visitor in creating lists, categories, and personalized tours. The ease of the interface and the synchronization of the application with the Wall itself allows those that are inexperienced with newer technologies to be able to have interact with it in relative ease.

The personalization elements with the ArtLens wall with the synchronization of the application gives the visitor the ability to narrow down and find the particular digital artworks that they are interested which they could then efficiently find through the application wayfinder in their physical form. These features of the wall and the application can also create some concerns. It may cause visitors to prioritize artworks and artefacts that they are already familiar with and may inhibit them from learning more about artworks that they are unfamiliar with.

Gaze Tracker, Artlens Gallery, Cleveland Museum of Art

The Gaze Tracker interactive at the Artlens Gallery encourages visitors to have a deeper and more critical examination of artwork; exploring the elements and artistic choices that affect the composition of an artwork. The technology uses an ADA compliant screen which then calibrates with the eyes of the visitor. Once calibrated the visitor will look at an artwork from the CMA's collection for approximately 15 seconds; simultaneously the eye tracking technology is accurately processing where a visitors' focus is when examining the artwork. Once the 15 seconds have surpassed, the interactive will have areas of the digitized art highlighted which reveal the path the visitors eye took while they were viewing the artwork.

The highlights will include what details they viewed the longest, which areas they ignored, and what they initially looked at in their first glance. At the end of the fifteen seconds, the interactive will then give an insight as to the intentions of the artist in regards to composition and vision. In addition to this, the visitor will also be able to view previous results from other visitors that have used the interactive (CMA, 2017).

Eye tracking interactive technologies have been becoming more common place within museum settings, and especially with this particular interactive it has the ability to create a social experience where multiple visitors can become involved. The interactive can help in initiating conversation amongst peers and groups, where it can spark educational conversation. Due to technological restrictions, the eye tracker is only limited to one person at a time. One concern with this is that it can potentially lure visitors away from wanting to use it due to the visitor being the only person going through the interactive and potentially having other just simply watching. Examining this potential issue through the lens of the contextual model of learning framework gives an insight on the importance of design. The physical context of the CML model places an importance on creating an environment where the visitor can feel comfortable and relaxed. Learning will occur more easily when the visitor is in a supportive environment where they are free from anxiety and fear. (Falk, Dierking, 2000).

In the first layer of CML model, the personal context layer, there are a few things that we can discern. It tells us that learning is something that is influenced by an individual's desire to both select and control his/her own learning. The visitor's personal context consists of their preconceptions and expectations that they have visiting the museum. The personal context derives most of its influence throughout the visitors past experiences and the knowledge that they currently have. With all this in mind, the personal context essentially is able to create the agenda for the visit. So when a visitor is engaged with an interactive, having options available is an important principle of the CML model. So in regards to Gaze Catcher interactive, the interactive does not give the visitor the option of choosing their preferred artwork, but rather it is a random selection based on the CMA collection database. Learning is best optimized when a visitor is able to control his or her actions as well as being able to select what they find is intrinsically appealing.

A novel feature of the Gaze Tracker is that it will give insight into the composition and some background information about the artwork after you have received the results of your gaze. By allowing the visitor to look closely with intent at artworks, visitors can help gain a better insight into what types of details are gaining their attentions. With this information

they can then apply the new information to form better insights and analyse more critically in terms of composition of artworks. This also falls in line with the Visual Thinking Strategy, it essentially states that concepts and designs in art museum usually will be beyond the what Vygotsky calls the "zone of proximal development" (Vygotsky 1978). The "zone of proximal development" explains that within educational settings, concepts are at times introduced that are too abstract or technical in comparison to what the viewers everyday knowledge is; hence the concepts will not be learned and will not be meaningful for the visitor. The strategy states that visitors should be taught how to construct personal meaning based on previous knowledge and what they are able to see. The approach that Vygotsky takes is one that the CMA has initiated with the Gaze Tracker interactive. The interactive allows visitors to be able to create their own meaning making. The interactive also has the ability to bring about questions about the analysis just through the examination of the artwork, allowing them to make connections and learn through by providing information on the artwork after their initial examination.

Overview & Suggestions

Research by John Elkin at the School of the Art Institute of Chicago indicated that museum visitors will view an artwork for an average of 2 seconds, then they will spend 10 seconds reading the label attached with the artwork, they then will take one more quick look at the artwork again and then leave. When the Cleveland Museum of Art(CMA) first conducted initial tests with the Gaze Tracker, the CMA discovered that visitors spend an average of 76 seconds engaging with each work of art after they have received their results (source). It seems that the Gaze Tracker does help in getting visitors to think more critically with the artwork, but to enhance the interactive for a more personalized experience there are other methods that can improve on the existing interactive. One change that can be made is to allow the visitors to have a more personalized experience. Allowing visitors to select from categories that are provided is a better option than having them choose from a randomized artwork selected from the exhibit.

ARTLENS Gallery Overview

The artlens gallery has done a very good job in stepping away from the idea that they need to serve the learning demands of the "masses". They have created an environment where the visitors are capable of "free-choice learning" for a majority of the exhibits in the gallery. The exhibits give the visitor the capability to have "free choice" over there experience. As spoken about earlier, this is especially prevalent with the ArtLens wall. Although in the Gaze Tracker, not being able to have a choice in the artwork can be seen as problematic to the engagement and learning process.

As spoken about earlier in the paper, in other types of museums such as science and natural history museums the interactive exhibit can be the main object of the experience and that is acceptable in those institutions. In art museums where the art themselves should constitute the main experience of the museum, implementing interactive exhibits can be more problematic. The ArtLens studio has done an effective job in being able to handle these challenges. They have been able to allow visitors to see art in a new and novel ways with the technology. They are learning about art that through exploratory means such as the Gaze Catcher and the Artlens Wall, while also having the main focus of the exhibits centered on the artworks themselves and not getting too focused on the technology.

CML model places an importance on the how the large scale property of the space, lighting, and total ambience are within the whole museum space. These are factors that can be as important as the actual content itself. It is an important step to turn our focus on the whole configuration of ARTLENS gallery as well as solely focusing on a singular interactive. Visitor learning has a strong relationship with the orientation of the space that the exhibit occupies. Having an environment where the visitor can feel comfortable in will help enhance their engagement and help reduce their "threshold fear". Threshold fear is term that essentially means the visitors can at times perceive art museums as exclusive property of the of the upper classes and the affluent which can ultimately constrain the visitors engagement and interest in the art museum (Gurian, 2005). In regards to the ArtLens Gallery wall and the Gaze Tracker exhibit, they are both situated within an overall space configuration which would allow visitors to feel comfortable and ultimately help encourage an engaging environment. The ARTLENS gallery has created an environment where the exhibitions are configured with a fluidity and organization when going from one to another. They have their own separate area of the museum consisting of two rooms. Research by Falk and Dierking

has reiterated this idea, they state that when exhibitions are fragmented from one another and there is little organization, visitors will not be able to engage as well (Falk, Dierking, 2000).

The innovation and new technological advances in multi-touch technology has helped make these types of interactives an attractive choice for art museums. Previous research has also shown that art museums have traditionally had issues in being able to attract teenagers and children to art museums. But with the implementation of new multi-touch technology it has become an attractive option for engaging and helping visitors learn in museum settings (Marshall et al., 2011). In addition to the ArtLens wall, a majority of the other exhibits within the CMA also implement multi-touch screens in their interactive experience.

Also, all sixteen of the interactive models have a participatory option to them where it allows visitors to engage in the interactive in groups. Although some may come with limitations, such as the Gaze Tracker, which allows only one person to interact with the exhibit. Even still, the interactive provides content and is designed in a way to help visitors get engaged in conversation with one another as highlighted earlier in the text.

Figure 2. A section of the ARTLENS gallery, it is a large open environment with little to no boundaries between exhibits.[Retrieved May 10, 2018 from: http://wangyang.io/ArtLensCMA]

Figure 3. The ArtLens 40ft. multi-touch system which gives visitors the opportunity to all simultaneously interact with the wall, having up to sixteen separate windows open across the collection wall. [Retrieved May 10, 2018 from: https://mw2014.museumandtheweb.com

Figure 4 & 5. The Gaze Tracker is able to highlight the details visitors viewed first as well as the details they viewed for the longest duration of time. [Retrieved on: May 10, 2018 from:

https://mw2014.museumsandtheweb.com/paper/gallery-one-the-first-year-sustainability-evaluation-process-and-a-new-smart-phone-app/]

Lumin Exhibit, Detroit Institute of Art

History & Description

Lumin, is an exhibition that premiered on January 25th, 2018 at the Detroit Institute of Art. The exhibition creates an interactive experience through the use of augmented reality and 3-D mapping. The Lumin is made available through 6.4" Android smartphones (Lenovo Phab 2 Pro). The exhibition has been created through partnerships with Google and mobile developer GuidiGO. Each of the phones have Google Tango software implemented which provides access to an augmented reality feature. In addition, it also uses GuidiGo's AR COMPOSER, which has the ability to have motion-tracking, depth-sensing and area-learning. The motion tracking gives the phone the ability to know where its located through space. The phone is able to sync the digital map creation of the museum and combine it with the real world. The first step of the phone is to localise itself and map where it is in the environment prior to loading up a 3D map of the point where the visitor stands in the museum. The point at where the visitor stands is is marked by a blue dot. The Detroit Institute of Art is the first museum in the world to implement the 3-D mapping and augmented reality for a public audience exhibit. The area-learning is then engaged and is able to mark areas that it has registered and mapped before and is able to map the augmented reality content with the real world. The Lumin exhibition currently has seven 'stops', these seven stops are:

1. Babylonian Empire- a 3D reconstruction of the Ishtar Gate.
2. The Colors of Carved Stone - the stone artefacts are overlaid with A.R. in with the technology then provides a visualization of how the stone artefacts looked at the time of creation .
3. Mesopotamia Property - examining old seals and documents and examining how they were signed.
4. Mummy Care, Inside and Out - Gives you an x-ray overview of a mummy, allowing the visitor to get a better insight on how they died.

5. Transformation of a Tree Stump - You tap the stump and determine how it was used as a royal presentation bowl
6. The Water Filter of the Islamic World - Gives you a better insight on the workings of a kilga, an Islamic water stand and filter.
7. Native American Stand - Find images of a thunderbird by listening to noises that are storm related.

(MW, 2017)

All seven of the interactives are presented as a world tour and through the wayfinding system on the phone it will guide you through each one. All seven of these interactives make use of the augmented reality technology. The scope of the analysis will primarily be focused on the software and technology of the AR and its impact on learning and engagement.

ANALYSIS

The wayfinding system map that is offered to you is a feature that can be seen a positive but it does also have some downsides as well. The interface of the wayfinding system will display blue dots within the phone the screen which will trace the path the visitors needs to take to get to the next interactive 'stop'. Screen based interactives, as spoken about earlier, will often end up interfering with the direct engagement of visitors within the exhibition and the place, at times isolating the visitor and diverting their attention from the real physical objects that are on display (vom Lehn & Heath, 2003)

The Lumin interactive is a form of place-based learning through A.R. technology. Place based learning occurs when the A.R. is emphasized through a physical area or being able to move through a physical environment (Rosenbaum et al., 2007). The Lumin exhibit which is centralized with place based learning helps create a sense of authenticity to the visitors; potentially helping visitors feel more in tune with the A.R. since they are working and moving through an actual environment. One thing to keep in mind is that place-based learning will need to take into account the restrictions and constraints that may be found with the actual environment. Now the wayfinder system in the Lumin exhibition will help the visitor maneuver around the Lumin interactives. The issue is that the Lumin interactives are all situated in area of the museum that also contain other non interactive artefacts. So when

you are engaged with the wayfinder system, which is guiding you from through the different interactive stops it is also can be a feature than can divert your attention from experiencing the other traditional artefacts that are on the path of the of the wayfinding route.

The Lumin exhibit implemented the augmented reality interactive with 7 different artefacts from the museum. Each artefact that is part of the lumens exhibit is distinctly different from the other; these are differences that are physical, historical (age of artefact, culture derived from, etc). This variety amongst the artefacts allows the visitor to gain a deeper insight with the interactivity. By having artefacts that vary, the museum allows itself to appeal to the diverse amount of visitors that will be visiting the museum. This is one of the main factors that are apart of the personal context section of the CML framework. Another key factor of the personal context is the ability for the respective exhibit to give 'personal choice' to the visitor. The Lumin exhibit, it is limited in the amount of choice that the visitor has at his disposal. The relationship between each the technology and the artefact are quite simple in its initiation. You engage with the A.R. and superimpose the virtual objects and layer them over the physical objects/environment; giving the visitor an enhanced perspective of the artefacts. But the problem is that it is not very dynamic and does not give the visitor enough choice within the experience. For example, with the Egyptian mummy exhibit the A.R. reveals the skeleton of the Egyptian mummy and allows the visitor to get a close examination of the bones. Although a novel feature, there is not enough choice within the experience to fully engage the visitor. The other interactives within the Lumin exhibit have similar experiences. The ability to have a choice and giving the visitor control over their interactive experience is an important aspect of learning and engagement according to the CML framework.

Overview & Suggestions

Overall, when judging the exhibition by some of the main principles of the contextual model of learning theory, there are some aspects of the interactive that can be improved upon. In regards to free-choice learning, they do an effective job of creating an interactive where visitors have the ability to experience the Lumin exhibition with multiple different artefacts within the museum. To reiterate, there are seven "stops" within the exhibition, with each stop covering a different type of artwork or artefact that is vastly different from the other. On the other hand the lack of overall options with the interactive itself is a concern for learning and

overall engagement. To help visitors with this, it would be best create an interface which is more dynamic, instead of just a visual representation of the superimposed AR over the artefact, they can add other options visually where the visitor can explore deeper into the artefact. There needs to be other features implemented to create a more personalized, free choice experience and ultimately a better learning outcome for the visitor. One approach the Lumin exhibit can take is to implement a "funnel approach" to the interactive exhibit. The general set up of this funnel approach consists of attracting the museum visitor in the entry level such as those that are simply browsing through the exhibit, and for those that have given their full attention, provide a narrower and deeper learning to those that want to invest more time with the exhibit. Through this process it will give them a deeper and a more detailed experience and will provide suitable choices through the layers of the exhibit (Schauble&Bartlett, 1997). The funnel approach to design also falls in accordance with the personal context layer of the CML framework which emphasizes that for proper engagement and learning to occur the visitor needs to have the ability to choose and have options in their museum experience (Falk & Dierking, 2000).

The Lumin exhibit is also stated to be designed for people of all ages. For the younger population, especially children, the Lenovo Android device in which the visitors are given for the A.R. technology can potentially be problematic. According to the research at the Samsung Digital Discovery Centre at the British Museum, young children might have trouble holding the tablet or phone device stable with one hand, while also trying to tap the screen and synchronize the artefact to the A.R. technology with the other (BM, 2013). The lumin exhibit also requires a tap onto the screen to synchronize the artefact with A.R. layering. This is an issue that can be resolved with a more fluid interface which does not require the use of synchronizing with touching the device screen. In addition to that this issue can also potentially be alleviated by the children watching adults use the interactivity, which can help them with the scanning process of the A.R. A study by Dunleavy et al. (2009) also has reported that students can at times feel pressured and overwhelmed when they are interacting with AR technologies because they are dealing with unfamiliar technologies that are then combined with complex tasks.

One additional suggestion can be to change the configuration of the Lumin Exhibit within the museum. Instead of having the seven stops within the exhibition be scattered and mixed amongst other non-interactive artefacts. Re-configuring the space and placing the interactive artefacts in a designated space of its own, rather than integrated with other non-interactive artefacts will help engage and keep the attention of the visitor more efficiently compared to

having them mixed together. This will also reduce the chances of a visitor ignoring non interactive artefacts. There is research that has indicated that design features will influence learning, particularly design features such as the sequencing and positioning (Bitgood & Patterson, 1995; Falk, 1993; Serrell, 1996). Positioning and configuration of an exhibit is also a main principle within the physical context layer of the Contextual Model of Learning framework, which highlights that since museums are free choice learning settings. The experience should generally be a voluntary, non sequential, and highly reactive to what the setting affords (Falk & Dierking, 2000). Placing the exhibit in its own designated area, with a non-sequential presentation of the exhibit would be an effective configuration to implement.

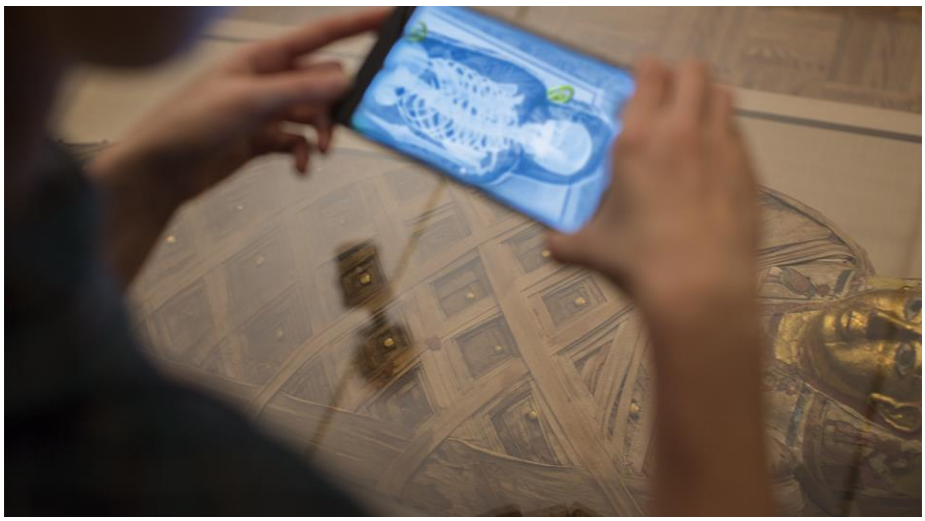

FIGURE 6. The combination of augmented reality technology gives you the ability to see the skeletal structure of an Egyptian mummy. [Retrieved on: May 10, 2018 from: https://www.dia.org/sites/default/files/image-508Copy%20of%20Google_Tango_HeaderPhoto_01.png]

Figure 7. The Colors of Carved Stone exhibit, the A.R. technology allows the visitor to see the original colors of the Mesopotamian reliefs. [Retrieved on: May 10, 2018 from: https://www.freep.com/story/entertainment/2017/01/21/lumin-detroit-institute-arts-dia-google/96791024/]

5. Conclusion

The premise of this paper focuses on how newer innovative technologies are having an impact on learning and engagement within art museums. The paper provided three different case studies which all presented interactive technologies that were all distinctly different from one another. Two case studies from the ARTLENS gallery, one which analysed 40ft. Interactive multi-touch display, and another which incorporates eye tracking technology. The last interactive is from the Lumin exhibit at the Detroit Institute of Arts which predominantly centered around augmented reality technology. Using the Contextual Model of Learning theory by Falk and Dierking, in addition to other academic sources and theories, a qualitative analysis was conducted to see how learning and engagement is being initiated within these interactive technologies. As this study has shown, the interactive exhibits in the ARTLENS gallery as well as the Lumin exhibit at the Detroit Institute of Art all bring innovative and interactive features for visitors. All three of the case studies showed obvious implementation strategies that place an importance on personalization and free-choice. Which if viewed

through the Contextual Model of Learning Framework, all have a importance in learning. Additionally, the interactive technologies allow visitors to get a variety of information through different senses, as opposed to the traditional style of art museum which is typically a static one to one experience.

5.1 Further Research

One issue that was present in the analysis was the concern of the visitors distraction while they are interacting with the exhibits. All three of the exhibits make use of screen based technologies which are connected to gps wayfinding systems. Can these devices potentially cause a distraction from the real artefacts that are on display?

Additionally, the Contextual Model of Learning Framework is set up into three separate sections. One thing to further research within the museum setting is if all the principles of the framework have equal importance, or if there are sections of the framework which have a stronger influence on learning and engagement, more so than others.

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