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Physical, Digital or Phygital? Assessing the Educational Potential of Virtual Reality in Heritage Interpretation

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Abstract
For decades technology has strived to provide an alternative virtual representation of heritage, and in recent years technology has become so powerful and accessible that is has supported an increasing trend in the creation and consumption of virtual heritage. Google Arts and Culture has contributed to this digitisation drive. The trend, though evident before the Covid-19 pandemic, registered an acceleration as heritage institutions could only provide online and virtual heritage experiences during the mandatory lockdowns. This paper presents the results of applied research on Google Arts and Culture Wonders of Malta and a cinematic VR production of a World War II air-raid shelter in Malta. Students at the Institute of Tourism Studies, Malta, participated and contributed to the analysis of the educational potential of this virtual heritage. Results show that the VR experience of Google Arts and Culture Wonders of Malta is rather limited in terms of presence and engagement, while the air-raid shelter cinematic VR successfully addressed some of these issues. However, the phygital experience, i.e. a visit to the physical site and the virtual reality experience of the same site, is the preferred combination for students.

Keywords: Virtual heritage, Virtual Reality, Google Arts and Culture, Heritage Education

Literature Review

The idea that it would be possible, one day, to perfectly recreate the physical world in the virtual domain of computers can be traced as far back as the 1960s, when computer scientist Ivan E. Sutherland coined the term 'ultimate display'. He explained that

> *the ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate*

> *programming such a display could literally be the Wonderland into which Alice walked (Sutherland, 1965, p.508)*

In subsequent years he further elaborated on his idea, based on the exploitation of the functions of the retina in the human eye and how it can be tricked to perceive two-dimensional objects as three-dimensional ones on computerised displays (Sutherland, 1968).

The idea was explored further in the 1970s and the 1980s when Jaron Lanier is credited with suggesting the term 'virtual reality', the defining term applied to these attempts to recreate reality through computing technologies (Lanier, 1988 and 1992). The first attempts at an ontological explanation of these new possibilities created by computer technologies were also made. Warren Robinett (1992) provided a taxonomy of what he described as the "synthetic experience". Complementing Robinett, Paul Milgram suggested the "reality-virtuality continuum" (Milgram et al., 1994). The cross-fertilisation of ideas continued with the Milgram-Weiser Continuum (Schmalstieg & Hollerer, 2016) that distributed various interface paradigms over two axes, depending on the technology, ubiquity and level of reality they incorporated. Thus, the terms 'virtual reality', 'augmented reality' and 'mixed reality' had become part of the vocabulary in the experimentation and development in this area.

Bekele et al. (2018) provide these working definitions for the major experience on the virtual reality continuum:

> *Augmented Reality: aims at enhancing our perception and understanding of the real world by superimposing virtual information on our view of the real world.*
>
> *Augmented Virtuality: aims at augmenting the virtual world with scenes from the real world.*
>
> *Virtual Reality: aims at enhancing our presence and interaction with a computer-generated environment without a means to interact with or see the real world.*
>
> *Mixed Reality: aims at blending real and virtual environments. (p.4)*

This paper is focused on virtual reality (VR).

Presence and immersion

As much as the research was based on the affordances of computing and digital technologies, the effects of the application of these technologies, in particular the socio-psychological sphere of life, attracted the attention of scholars and

researchers. One of the first themes to be studied was the role of 'presence', or how the human body experiences a place that does not exist except on a digital screen supplied by the computing device. Steuer (1992) provided a new variable-based definition of VR in relation to other media, a mediated experience of presence and telepresence whose extent also depends on the quality of the display. Slater and Wilbur (1997) proposed that

> *the degree of immersion can be objectively assessed as the characteristics of a technology and has dimensions such as the extent to which a display system can deliver an inclusive, extensive, surrounding and vivid illusion of a virtual environment to a participant. (p.606)*

They also made an important distinction between 'presence' and 'immersion', suggesting that presence is a result of the user's psychological experience of the place while immersion is the quality of the technological system and the degree to which it shuts out physical reality and replaces it by the virtual environment. The outcome is that "the more immersive the system, the more likely an individual will feel present within the mediated environment and the more likely that the virtual setting will dominate over physical reality in determining user responses" (Cummings & Bailenson, 2016, p.274).

The interplay between technology and psychology remains contested ground in terms of empirical research. Jason Jerald emphasises that both the technological side and the psychological side are both important in VR, and that "we must create VR experiences with both emotion and logic" (Jerald, 2015, pp. 1-2).

Sherman and Craig (2018) identified five key elements in the experience of reality, whether virtual or not. These are: a) the virtual world, b) interactivity, c) immersion, d) the creators of the experience and e) the receivers of the experience. The most important element is the participant (receiver): "All the magic of VR happens in the mind of the participants, hence, every VR experience is different for each of them, because each brings their own capabilities, interpretations/ background/ history, and thus experiences the virtual world in their own unique way" (ibid., p.6). The participant can be given agency through haptics.

Sherman and Craig (2018) also note that there is still much confusion in the terminology of VR, as a result of the technology being "young and evolving rapidly" (ibid., p.58). One example is surround or 360-degree movies, sometimes also referred to as cinematic VR, which can be experienced in a room or with a head-mounted display and the view for the user changes as the head is rotated (ibid., p.13). While cinematic VR gives the user very limited control of the experience, it can still establish presence and create compelling

storytelling when film-making techniques are applied (Mateer, 2017). This can create a strong emotional effect on the user, making them believe they are walking in someone else's shoes, and it is a very effective immersive storytelling technique (Jones, 2019). This is also applied to telling stories from history (Argyriou et al., 2020).

Marasco's (2020) qualitative study of five cinematic VR projects observed that the storytelling approach was successfully implemented in terms of the education, awareness and edutainment objectives.

The availability of more powerful, more mobile and less expensive computing devices has increased the accessibility to VR experiences, to the extent that there have been several claims that "2016 was the year of VR" (Morris, 2015; Cellan-Jones, 2016). The wider availability of smartphones and cheaper computing power is considered a contributor to this major development, and there is hope that "finally this time the technology will answer the unfulfilled promises made in the 1990s" (Steinicke, 2016, p.31). The Google Cardboard has proved to be an inexpensive enclosure for a smartphone that can play VR experiences just like the more expensive headsets with incorporated computing power (Bown, White & Boopalan, 2017. Technology has attained the "potent ability … to trick the mind into belief" and induce the feeling of presence (ibid., p.255).

The significant technological developments that support the experiences along the 'reality-virtuality continuum' have still not answered some physiological challenges related to prolonged exposure to the human senses. Users of VR systems had reported dizziness, eye strain and as early as the 1990s (Nichols & Patel, 2002). Even when taking into consideration the technological advances over the past 20 years, prolonged use of VR systems is still reportedly leading to physiological issues, display image resolution being one of the factors (Desai et al., 2014; Theodorakopoulos, 2017; Kim et al., 2018; Chattha et al., 2020).

Education and heritage

The term 'virtual heritage' is used in reference to the presentation of heritage interpretation in digitised format. According to Stone and Ojika (2000) virtual heritage is

> *the use of computer-based interactive technologies to record, preserve, or recreate artefacts, sites, and actors of historic, artistic, religious, and cultural significance and to deliver the results openly to a global audience in such a way as to provide formative educational experiences through electronic manipulations of time and space. (p.73)*

Though there are other similar definitions of virtual heritage (Addison 2000, Addison 2001, Roussou 2002; Champion 2015), Stone and Ojika (2000) include the educational element in their definition.

Bekele et al. (2018) classify immersive reality cultural heritage into five, sometimes overlapping, categories: a) education: to learn about the history of cultural heritage, b) exhibition enhancement: to improve the physical user experience, c) exploration: discovery and interpretation, d) reconstruction: interaction with historical views, and e) virtual museums: exhibitions in digital format.

The educational potential of virtual and immersive cultural heritage experience has long been recognised, and already in the 1990s it was being suggested that "the history student can visit the Battle of Hastings, or the court of the Ming Emperors … In the future it will be theoretically possible for the VR participant to have a complete tourism experience without ever having to leave home" (Perry & Williams, 1995, p.129). 3D digital heritage models are considered sustainable scholarly resources (Champion & Rahaman, 2019). VR is viewed as complementary to other technologies such as digital multimedia content, online fora, and smartphone apps (Bower & Sturman, 2015; Minocha et al., 2017). Despite the claim by mainstream media that VR had come of age, it was still regarded as being in its infancy in its application in teaching and learning (Minocha et. al., 2017, pp. 9-10). The tourism and heritage industry did not wait for the impact of the Covid-19 pandemic to exploit digital technologies and create VR tours and experiences. Marasco (2020) mentions the Palace of Versailles (Paris), the Vatican Museums (Rome), the Smithsonian National Museum of Natural History (Washington D.C.) and the State Hermitage Museum (St. Petersburg) as examples.

The digitisation process of GLAM (galleries, libraries, archives, and museums) has been accelerated by the Covid-19 pandemic, a direct result of educational institutions and heritage institutions having to close down for months and transfer their activities online (Samaroudi et al., 2020; Spennemann, 2021). This digitisation also positively impacted the use of digitised cultural heritage in education (Sweeney & Tanaka, 2022). Chiara Zuanni, assistant professor in digital humanities at the Centre for Information Modelling at the University of Graz, Austria, deployed an interactive map [1] with the digital activities undertaken by museums during the pandemic. Europeana, the online repository of European cultural heritage, also promoted creative approaches involving technology in the era of the pandemic [2]. ICOM (International Council of Museum) issued guidelines on how museums can reach the public remotely, and these included virtual tours. Indeed, the European Union and its institutions have been at the forefront in promoting and supporting the cultural heritage sector in exploiting digital technologies. [3]

Heritage Malta, the Maltese national agency for preservation and management of cultural heritage in the Maltese Islands, took several initiatives related to digital technologies during the pandemic, included the launch of a website about the rich underwater heritage around the Maltese Islands [4], a virtual tour of the Ħal Saflieni Hypogeum, and extensive use of social media and YouTube. Its digitisation unit was expanded in terms of human and technical resources.

The re-opening of the heritage sites and the re-start of the tourism industry has also kindled the discussion on the complementary role of both the physical and the digitised experiences of heritage. The term 'phygital', coined from the amalgamation of 'physical' and 'digital', is being applied to such experiences. However, as with any new concept, there are both avenues for agreement and divergence in terms of understanding and perceptions. Nofal et al. (2017, p.220) define phygital as "the integration of digital technology 'into' physical reality, as a potential medium for more enriched and playful communication of heritage values and qualities". Ballina et al. (2019, p.163) go user-centric and provide a non-technological definition by suggesting it is "a generation of people for whom the real world and the digital world overlap". Debono (2021, p.158) warns against a narrow view of this relationship and suggests it "being potentially meaningful beyond the confines of the traditional physical museum space". The digital experience can successfully complement the onsite experience (Marasco, 2020). It is also an opportunity that sustains the renewal process of museums (Ballina, 2019). While the younger generations have heightened expectations that influence the phygital mix (Debono, 2021), tourists experience greater satisfaction when they perceive technology as being useful (Ballina et al., 2019).

Stone (2015) calls for a more human-centred design in virtual heritage for "Virtual Heritage must, out of necessity, engage with individuals from all walks of life, especially those who possess valuable personal recollections or material resources" (p.i). Champion (2015) stresses that "virtual heritage projects typically aim to provide three-dimensional interactive digital environments that aid the understanding of new cultures and languages rather than merely transfer learning terms and strategies from static prescriptive media such as books" (p.5). The past can also be made more engaging with the young generations who have a strong affinity with digital technologies, offering a strong educational proposition (Pujol et al., 2012). Furthermore, VR has a positive impact on learning regardless of the user's previous historical knowledge related to the subject content of the virtual experience (Ch'Ng et al., 2020). The virtual tour can be considered as "an online twin of the physical experience, but relatively restrained by comparison given its reliance on camera viewpoints" (Debono, 2021, p.163).

The application of VR to education is not a new idea (Helsel, 1992; Pantelidis, 1993; Hedberg & Alexander, 1994). While the educational potential of VR is not disputed, several authors have highlighted the challenges, especially the lack of proper pedagogical underpinnings of using VR in education (Fowler, 2015; Xiao et al., 2019). Hamilton et al. (2020) insist that "a rigorous methodological approach through the identification of appropriate assessment measures, intervention characteristics, and learning outcomes is essential to understanding the potential of immersive VR as a pedagogical method" (p.2). A constructivist approach is suggested from among the educational theories in the deployment of VR in education (Winn, 1993; Youngblut, 1998; Mikropoulos & Natsis, 2011; Black, 2017; Ch'Ng et al., 2020). Black (2017) forms part of this constructivist camp and and warns against technology determinism:

> My recommendation is that VR is most useful within a constructivist approach to education, where the learning software is used to help students determine for themselves thoughts about critical points in history. Strapping on a fancy headset will not directly teach students the emotional, economic, geographic, and political causes of history. Thoughtful curriculum design from passionate educators which includes primary sources, books, critical analysis, writing, discussion, feedback, and earnest self-questioning on behalf of the students themselves will continue to be the bedrock of history education. (p.57)

Champion (2015) notes that despite the effort and enthusiasm of the producers of the virtual heritage, interactivity with users is limited, the depiction of the inhabitants depicted in the productions as unrealistic and there is an issue with the presentation of culture, especially how cultural knowledge is transmitted through digital means.

Google Arts and Culture

Google Arts and Culture, launched in 2011, is just one of several online tools made available by Alphabet (the parent company provided the services under the brand name of Google) and other companies such as the Metaverse Studio Augmented Reality Platform and the 3D publishing platform Sketchfab to create virtual heritage. Maltese heritage (Figure 1) was launched in 2017.

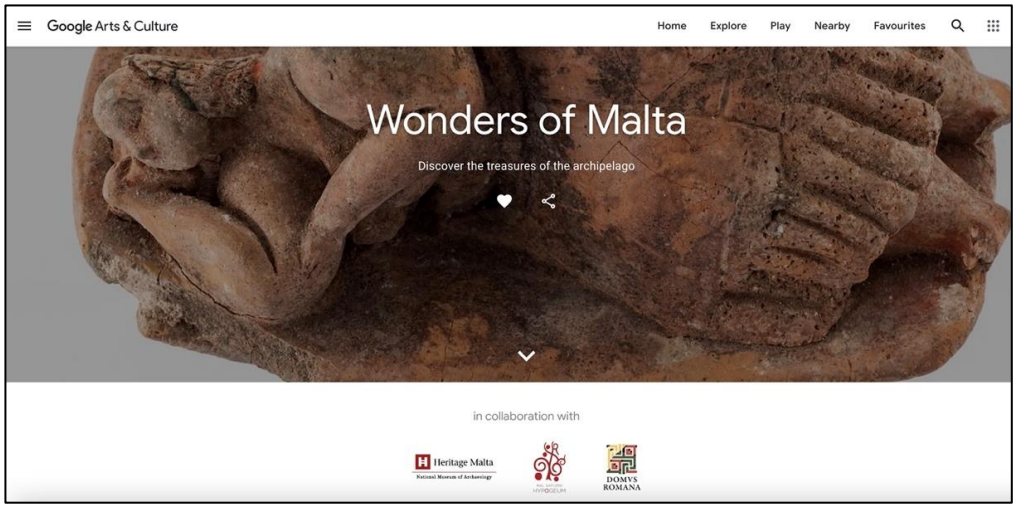

Figure 1. A screen grab of Google Arts and Culture Wonders of Malta as viewable on a computer screen (author's image).

While Google Earth Tour builder is still available at the time of writing, Google Poly and Google Expeditions and Tour Creator were previously available until the services were terminated by Google in 2021.

There is a lack of digital skills by global citizens to exploit tools that support the study, preservation and dissemination of cultural heritage. Google Arts and Culture can help in this regard (Ziegler Delgado, 2020) and it can be an "essential resource to stimulate the student's curiosity and bring any corner of the planet to the classroom" (Verde & Valero, 2021, p.49). It can promote the cultural offering of small places trying to get on the tourism map (Pascoal et al., 2020). In terms of value creation for stakeholders in the tourism and cultural industry, Google Arts and Culture is more effective than Europeana (Pesce et al., 2019).

However, Google Arts and Culture presents issues and challenges. These include anomalies in the representation of the real physical environment (Andersson, 2022); the reinforcement of state-sponsored and authorised heritage to the exclusion of other heritage (van der Knaap, 2020); and cultural colonialism with Google Arts and Culture over-representing the USA over the rest of the world and over-representing large Western cities and capital cities and under-representing the rest of the world in terms of city-size (Kizhner et al., 2020).

Google Cardboard, the low-cost enabler of the VR experience on a smartphone, has been proven to enable personal virtual experiences (Minocha et al., 2017) but users still experience dizziness with prolonged use with VR productions loaded on their smartphone and using Google Cardboard like other VR headsets (Theodorakopoulos, 2017).

In conclusion, this literature review has demonstrated that while digital technologies can be applied to cultural heritage, and this can have a strong educational element, there are both benefits and challenges that need to be addressed. Lack of digitals skills, lack of user interactivity, underutilisation of storytelling techniques and user empowerment are some of the issues. Technology has improved the level of immersion and presence in virtual reality productions. Education still needs to understand the pedagogical affordances of virtual reality and virtual heritage. VR is not a panacea, and Google Arts and Culture is offering cultural heritage experience of quality despite the reported limitations. The phygital experience, combining both the real-world visit and a virtual immersive experience of the same site through digital technologies, is currently the best combination in the post-pandemic scenario.

Primary data and analysis

The literature review has amply illustrated the interest in the application of digital immersive technologies to tangible and intangible heritage, also covering educational aims and objectives. Educators have been increasingly interested in these technologies as enablers of innovation in traditional pedagogies.

This development has prompted a two-phase research study that examined the application of VR to Maltese heritage in a Maltese higher education context. Students at the Institute of Tourism Studies (Malta), Malta's public higher education VET instutition specialising in tourism studies, participated in the applied research experiment between 2018 and 2020 in time before the Covid-19 pandemic caused a widespread closure of heritage sites around the world.

Phase 1 - Google Arts and Culture Wonders of Malta

The first phase of the study sought to address the research question "*Are learning outcomes equally attained by an onsite visit and a Virtual Reality experience of the same location?"* The students were exposed to the VR content of Wonders of Malta by Google Arts and Culture [5] and on-site visits. *Wonders of Malta* is one of the first nationwide attempts at creating VR experiences of the rich and diverse Maltese heritage and had been given widespread publicity locally.[6]

The sample was taken from students attending courses related to cultural heritage and tourism. Nine students (n=9) were attending a Diploma in Travel and Tourism at European Qualifications Framework (EQF) Level 4 and 12 students (n=12) were in the Higher National Diploma in Tourist Guiding course at EQF Level 5. The latter is a pre-requisite qualification by Maltese Law to obtain the official tourist guiding licence in the Maltese Islands.

The 21 students were divided into three experimental groups: one group was to do only heritage site visits (n=6), the second group was to experience only the Google Arts and Culture Wonders of Malta VR experience (n=7), and the third group was to have both the physical and virtual experience (n=8). The heritage sites were the Palace Armoury, Fort St. Elmo (including the National War Museum, see Figure 2) and the Archaeology Museum in Valletta; the Tarxien Megalithic Temples and Malta Maritime Museum in Vittoriosa. Students were assigned to the groups in equal numbers in a random manner, without any pre-testing of their knowledge of the sites and their history or their skills and experience in using VR. The participants used their own Android or iOS-based smartphones mounted on Google Cardboard.

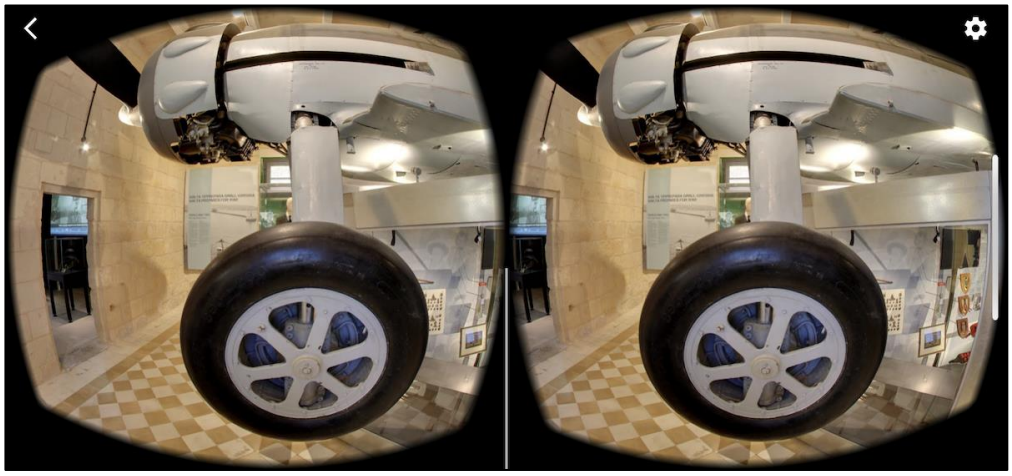

Figure 2. The Google Arts and Culture Wonders of Malta VR experience of the Gloster Gladiator biplane at the National War Museum, Valletta, as seen on a smartphone screen loaded on Google Carboard (author's image).

The assessment was in the form of a live class presentation for both EQF levels. In the case of the diploma course the criteria covered these knowledge, skills & competencies areas: a) the learner's presentation in class with information on the site and its exhibits (20%), b) a role play as a tourist and as information officer at the heritage site (40%), and c) the placement of the heritage site within wider heritage context and opportunities for professional development (40%).

The assessment criteria for the Higher National Diploma in Tourist Guiding were divided into three knowledge, skills & competencies areas: a) knowing the heritage site and its context (20%) b) planning and leading a guided tour on site with unforeseen challenges (45%), and c) the placement of the heritage site within a wider heritage context for the development of personalised tour guiding (35%).

The students who only had the physical experience on site scored the highest grades in their assessment, the students who went on site and had the VR experience obtained average grades while the lowest grades were registered by the group who only experienced the VR production. These results were unexpected as the general assumption based on the literature is that a combined physical and a virtual experience is better than just the physical or the virtual experience. The assessment grades were reinforced by a second round of data gathering, this time the collection of the participants' views on their virtual, physical or phygital experience. The participation rate was 95% with 20 out of 21 students responding to a short online questionnaire.

The responses from the students who only had the physical experience acknowledged the importance of going on site but also the potential of digital technologies to enhance the interpretation of the same sites. 60% said the VR experience cannot replace the visit to the physical site and 80% are convinced that a phygital experience would be the best option. One of the respondents commented:

I firmly believe that nothing beats being on site. That said, I am completely in favour of the availability of Virtual Reality because this provides additional options particularly to those who cannot visit the site.

The responses from the group that only experienced Google's digital production revealed a negative reception of what had been advertised in the Maltese media as "an unprecedented immersive discovery experience" (Times of Malta, 2017). 57% said they do not think Google Arts and Culture on VR is a substitute of actually going on-site, with only 29% saying it does and 14% saying they did not know. Another 57% only gave it 1 to 5 stars on a scale of 1 to 10 stars (10 being the highest) in terms of the educational potential of the experience. In this group, the percentage of respondents who indicated that the phygital experience would be ideal amounted to 71%.

The negative appreciation was clear in the comments: "*VR does not provide the experience and learning outcomes of an onsite visit because it is not complete and accurate, a glimpse of the actual site*". The main issues identified by the participants where the voice narration (86%), the mobile app causing physical discomfort (86%), the Google Cardboard did not work properly (67%), and the VR content is still not good enough (50%). The option that it is difficult to learn how to use a VR experience obtained zero preferences even though 71% had never tried a VR experience before. The robotic voice of the narration and the discomfort of participants with prescription glasses were major issues.

The student group who had the phygital experience were even more critical of Google's VR experience, being able to compare both the physical and the digital experience. Indeed, 60% of respondents gave it a rating of 5 or less out

of a maximum of 10 in terms of its educational potential, adding such comments as "*Virtual reality does not provide anything new or special*", "*VR leaves a lot of useful info unmentioned*", "*It gave me the option to explore closed places, but apart from that it makes no sense to see a real place you want to know with glasses ...*", and "*personally I feel that you do not get the full experience you would get if you personally go to museum*." The respondents' main challenges were identical to those indicated by the digital only group.

Most of the participants in this group, 60%, manifested their preference for a phygital experience while zero percent said they preferred to have the VR experience only.

A summary of the views of the three research groups in terms of their preference towards a phygital experience is given in Table i.

Student group by experience type	**Physical only**	**VR only**	**Phygital**
Percentage of participating students who indicated the phygital experience as being the best	80%	71%	60%

Table i. Preference by student group participants towards the phygital experience, divided by their experience during the research

This research had limitations. It only studied one VR platform (Google Arts and Culture Wonders of Malta), the participants' sample was small and limited to one educational institution only.

Summary of outcomes

The students who only went on-site registered the highest assessment grades and those who only experienced the VR production got the lowest grades. There was general agreement among the participants in all three experience groups that the best experience would be a phygital one. They did not perceive the Google Arts and Culture Wonders of Malta experience as constituting a reliable tool to support teaching and learning about Maltese heritage as it exhibited production and technological limitations. Hence, the answer to the original research question "*Are learning outcomes equally attained by an onsite visit and a Virtual Reality experience of the same location?"* is in the negative.

Phase 2 - The World War II air raid shelter VR experience

The results of the research on Google Arts and Culture Wonders of Malta stimulated the prospect of producing a new VR experience and improve on the challenges that had been mentioned by the participants. A cinematic VR experience of the World War II air raid shelter in L-Imġarr, Malta, was developed in 2019 and the experience was once utilised as the basis for action research with ITS students. [7]

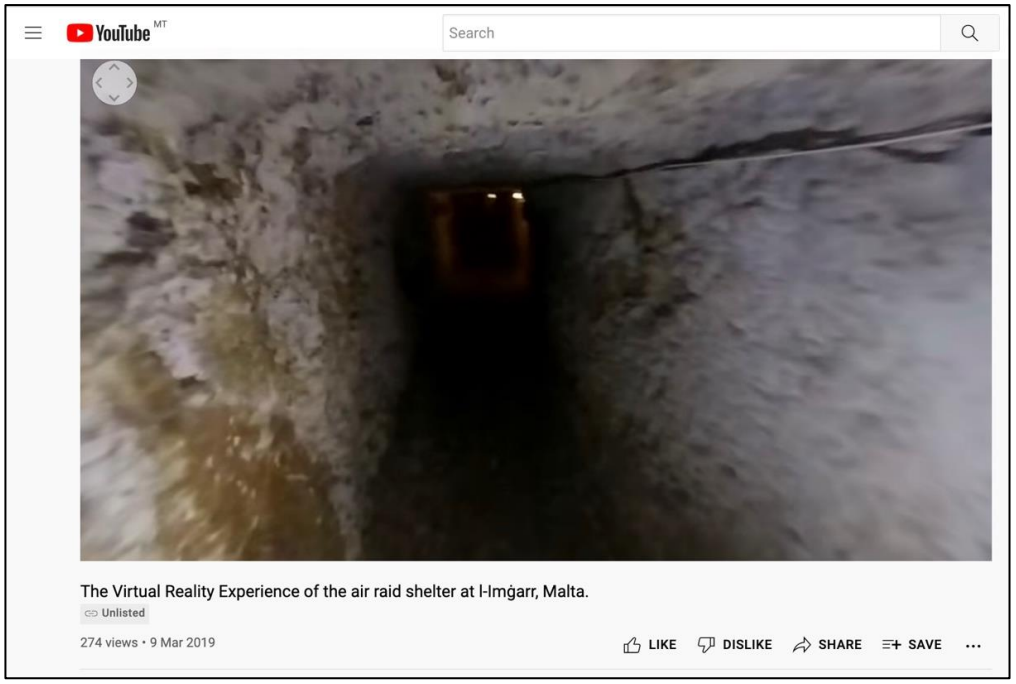

Figure 3. A screen grab of the World War II air raid shelter cinematic VR experience on YouTube (author's image).

The digital equipment for the development of the cinematic VR experience consisted of an Insta 360 One 360-degree camera and the Apple Final Cut Pro X editing software on an Apple iMac computer. The narration was by a human voice and not created with text-to-speech software. The script had been drafted in a storytelling mode, starting with a simple "*What you are about to see is part of Malta's history, etched in stone. When this chapter was written no paper was used. No ink was necessary. It was written in blood, sweat and tears*."

The narration, music and sound effects had been pre-recorded into one audio package by the management of the site to be played to visitors on speakers during the visits. It was provided to the researcher in MP3 format to be included in the VR experience. The whole production is 7.42 minutes long and is available on YouTube [8]. The consumption device used in the experiment

was an Apple iPhone XR mounted on Google Cardboard. Optional earphones were used to listen to the audio.

The comparison between the Google Arts and Culture Wonders of Malta and the air raid shelter experience delivers the characteristics listed in Table ii:

Production characteristic	**Google Arts and Culture Wonders of Malta**	**Air Raid Shelter**
Motion	Tap-enabled user control to move from one location to another. User control on the movement of the head and direction of view	Cinematic VR with user control on the movement of the head and direction of view. No control on movement in the site
Resolution	High definition	High definition
Sound	No sound effects or background music	Sound effects and background music
Narration	Text-to-speech software enabled	Human voice recording
Interactivity	Yes – the user moves from room to room in a pre-determined path	No - simple video start, pause and stop functions
Immersion	Total with a VR headset or Google Cardboard	Total with a VR headset or Google Cardboard
Haptics	None	None
Heritage interpretation	Simple historical facts	Historical facts in storytelling narrative format
Access	Through a website on a smartphone only	On YouTube accessible on both a computer and a smartphone

Table ii. A comparison of the technical and interpretation characteristics of the Google Arts and Culture Wonders of Malta and the air raid shelter cinematic VR production.

Utilising the definition of VR provided by Sherman and Craig (2018), the air raid shelter experience qualifies as a mentally immersive augmented reality 360-degree cinematic VR on a head-mounted display. The point of view is limited (the one presented by the video movement), there are no haptics, very limited interactivity, and limited sense of agency.

The set research question to study the effects of the air raid shelter experience was: "*Can the creation of an immersive digital experience of original heritage replace the experience and resulting interpretation of the real thing?*"

The research sample of students from ITS was divided into two groups. The first group of 44 students (n=44) in the Certificate in Travel and Tourism (EQF 3) were only exposed to the VR experience. The second group consisted of five students (n=5) in the Higher National Diploma in Tourist Guiding (EQF 5) and these were first exposed to the VR experience and then went to visit the air raid shelter in L-Imġarr. The EQF 3 students were aged 16 to 18 while the EQF Level 5 students were all over 24 years and thus the latter were considered as mature students. This demographic could be a factor in the responses obtained. None of the participants in this research had taken part in the previous research on Google Arts and Culture Wonders of Malta discussed in this paper.

The participants in the exclusively digital experience used their own Android or iOS smartphone on Google Cardboard. The production was accessible on YouTube via a URL and the experiment was held on the ITS campus.

70% of participants with the exclusive virtual experience said that the VR experience is a substitute for actually going on site, while 21% said this was not the case. None of the participants had gone on site. However, the participants had a different approach if there was the option of a phygital experience. In fact, only 18.2% said they would choose the VR only if they had the choice while 52.3% would take the phygital option and 11.4% would only go on site. Asked about the educational potential of the experience, respondents gave an average of 6.74 out of a scale from 1 to 10, which is better than that score obtained by the Google Arts and Culture Wonders of Malta.

The participants commented: "*While VR is fun, it doesn't give the same atmosphere feeling and visual quality*", "*being there has a more realistic feel in temperature and real life, but then you can still get a good experience from VR*", "*The video was nice but I got dizzy looking at all the stones*". The last comment referred to the physiological issues with the VR experience already mentioned in the phase one research and the literature review.

The group who had the phygital experience overwhelmingly voted for the phygital experience (80%) when asked to choose between the physical, digital

and phygital experience. The rest indicated the physical experience. This choice was underlined by some of the participants' remarks, such as "*I think the VR experience is very interesting, but … I still prefer the real on site*" and "*you will never get 100% the feeling of the place without being there*".

Asked about whether they thought the 360-degree multimedia experience will one day develop to such a degree that it becomes a substitute to actually going on site, 60% disagreed, one participant explaining "*because it will never involve all senses*".

The participants were quite precise in their indications as what the digital experience cannot replicate from the physical one: "*Humidity, uneven floor in some areas*", "*The involvement of all senses and the physical walk through, but the virtual experience was surprisingly truly claustrophobic*", "*The smell, the sense of discovery while walking, the anticipation of what to find around every corner*" and "*Smells, perception of size, being fully in control of the tour (e.g. walking wherever I wanted to)*".

On the other hand, the digital experience did provide elements that were not available in the physical experience: "*there was no danger to walk, no sign to mind your head etc …*", "*The narration is synchronised with the timing of the VR. While on site, you take longer to walk through and the narration would have stopped earlier than your visit*" and "*Potentially location, being able to do it remotely. Also pausing and replaying*".

This research group who had the cinematic VR experience gave an 8.0 rating on the scale of 1 to 10 in terms of the educational potential of the experience. These were the reasons given for their positive vote: "*effective claustrophobic effect*", "*no wasted time for travel. for a basic experience it works well*", "*the inconsistent movements give physical discomfort", and "Reminded me of playing video games*".

The WWII air raid shelter digital experience scored better in terms of the quality of the production and the educational potential than the Google Arts and Culture Wonders of Malta. The participants' responses and open-ended comments reflect literature and its highlighting of the challenges and restrictions of recreating reality in terms of immersion, presence, education potential, health issues. As a result, the answer to the research question "*Can the creation of an immersive digital experience of original heritage replace the experience and resulting interpretation of the real thing?"* is in the negative. However, this can be also understood as being 'not yet' rather than a straight 'no' and the phygital experience seems to be the best option to interpret heritage.

The second phase of research had its limitations. Once again, the sample of students was small and from one institution only. Only one VR experience about one heritage site was used.

Discussion of findings

The research has been done before the outbreak of the Covid-19 pandemic that resulted in the closure of museums and heritage sites and subsequent hurried attempts of these institutions to enhance their online presence and digital offering.

The negative responses on the Google Arts and Culture Wonders of Malta VR experience can be attributed to the fact that the production did not deliver a quality experience in any of the five categories of immersive reality cultural heritage proposed by Bekele et al. (2018, pp.16-17). The students' low assessment grades definitely prove a deficiency in the educational aspect, while the students who experienced both the heritage sites and the VR production did not see any exhibition enhancement or a heightened sense of exploration in the VR experience. On the other hand, the air raid shelter cinematic VR experience scored well with the participants in terms of these categories.

While the physiological issues with using Google Cardboard were confirmed with the participants, no major issues with the representation of the physical environment (Andersson, 2022), cultural bias and colonialism (Kizhner et al., 2020; van der Knaap, 2020) were raised by the participants.

The technology investigated in this research is nowhere near Sutherland's 'ultimate display' (Sutherland, 1965). The participating students did not feel the humidity of the place, but the cinematic VR production did relay the claustrophobia of the underground site.

Immersive digital technologies can create a complementary experience, but they are not yet perceived as a substitute for the real environment in terms of presence. The sense of presence is limited: smelling, feeling the environment (e.g., temperature and humidity) cannot be replicated virtually yet. The technology is not mature enough to completely replace the physical site (full immersion and fully replicable presence).

Potential for further research

With the re-opening of GLAM sites and the recession of the Covid-19 pandemic, the opportunity to study a heritage site and the digitised interpretation of the site is again possible. In the case of the research presented in this paper, the educational impact of the air raid shelter needs to be

measured and the experience inserted in the wider context of the interpretation of the Second World War.
This research was limited to the VR productions of Google Arts and Culture Wonders of Malta. Other 2D digitised content, e.g., the paintings, artefacts, and buildings, of Maltese heritage was not studied.

Endnotes

[1] https://digitalmuseums.at/
[2] https://pro.europeana.eu/page/creative-approaches-and-collaborations
[3] https://ec.europa.eu/digital-single-market/en/news/public-consultation-opportunities-offered-digital-technologies-culture-heritage-sector
[4] https://underwatermalta.org/
[5] https://artsandculture.google.com/project/wonders-of-malta
[6] The results of this research were first presented at DRHA 2018 in Valletta, Malta. See https://www.drha.uk/
[7] The results were initially announced at DRHA 2020 held virtually in September 2020 because of the Covid-19 emergency. See https://www.drha.uk/salford2020/wp-content/uploads/2020/09/DRHA2020-book-of-abstracts.pdf
[8] https://www.youtube.com/watch?v=1sPBUOZPY-A

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