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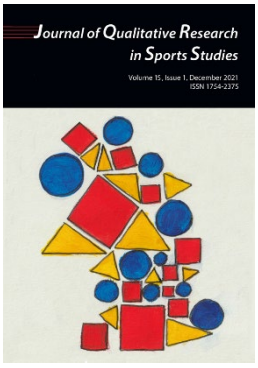

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When nature and tech connect – a case for using Augmented Reality in the Outdoors

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Keywords: *Augmented Reality, physical engagement, mobile technology, outdoor learning*

Abstract

This paper promotes the adoption of Augmented Reality (AR) to inspire children and collaborative family engagement in the outdoor learning experience. AR, being a form of digital mobile technology, was deployed at the English Heritage site of Tintagel in Cornwall, on the south coast of Britain. Tintagel was selected for its dramatic coastal environment, as well as its rich history of myths and folklore around the Legend of King Arthur. *The Enlighten Project for English Heritage* was designed and trialled by the first author, forming a business case / proposal for further development of AR across other English Heritage sites. The implications and opportunities for AR in learning are discussed re: the uptake of 'tech' by digital natives – young people who have grown up with tech ever present in their lives. The tensions between experiencing the outdoors both with and without technology are navigated through a reflective log. In conclusion, it is acknowledged that the use of tech may be an unstoppable force in our daily lives, so embrace and enjoy the ride!

Introduction

This research was designed to bring together my passion for exploring the outdoors with my lifelong career as a digital graphic designer and educator. Richard Louv (2012:8) states that 'utilising both technology and the nature experience will increase our intelligence, creative thinking, and productivity, giving birth to the hybrid mind'. I am a natural creative who also enjoys the outdoors and so it felt compelling to look towards a research project that might one day merge these two fields of practice in a new and exciting venture. Thankfully, Augmented Reality has given me the opportunity to do this.

Despite my *yin-yang* relationship with the use of technology in the outdoors, 'tech' is all around us and it is here to stay. In the words of Steiner-Adair (2013:iv), 'we live in the glow of the digital age, and we're hooked on tech'. No matter how hard we try to promote the value of Outdoor Education to adults and children alike, we are forced to accept the reality that technology is always there, lingering in the background of people's minds, pockets or backpacks, and never more so than with the current digital native generation - our children, who have grown up with tech.

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When technology is used correctly it can both support and enhance learning, however, when we consider Outdoor Learning, utilising new technological innovations is rarely the obvious choice. Anggarendra and Brereton (2016) suggest that using technology outdoors can deepen children's engagement with nature, set the stage for learning, and equip families to integrate outdoor exploration into their everyday lives. For some, keeping the outdoors as a tech-free zone is vital for children's health and wellbeing (see Louv, 2005: *Saving our Children from nature-deficit disorder*) and as a parent who has had concerns about my children's screen time use (see Thomas and Palmer 2020: *When mother earth gives birth to a digital demon*), I understand what reservations individuals may have. But if technology can present information through a means that better connects with our children, then surely it is worth investigating further.

This personal commitment to technology and the outdoors prompted my involvement with the *Enlighten Project for English Heritage*. My research was a proposal to them for using mobile tech outdoors to get children active and interacting with nature, whilst learning about the history, heritage, myths and legends of an area. With the Augmented Reality feature now available on most mobile devices, adults and children have the potential to experience almost anything that was once out of reach. At the click of a button, we can step back in time and see for ourselves what life was once like during a different age and survey the landscape as it might have been. Anything that was once written about in textbooks can now be constructed and experienced in a more interactive way. For visual learners like myself, these vivid memories (and the digital souvenirs acquired) stay imprinted in my mind. Augmented Reality is giving rise to exciting new ways of learning and exploring in the outdoors (e.g. Panou, Ragia, Dimelli and Mania 2018; Challenor and Ma, 2019).

When Nature and Tech Connect – The Enlighten Project for English Heritage

The ancient Chinese Proverb of the Shuo Yuan stories, 3rd Century BCE states:

> The ear's hearing something is not as good as the eye's seeing it; the eye's seeing it is not as good as the foot's treading upon it; the foot's treading upon it is not as good as the hands differentiating it.

In the modern day, this can be expressed as:

Tell me, I'll forget.

Show me, I'll remember.

Involve me, and I'll understand.

This has become a watch-word for many educators, especially for myself in my day job as a college lecturer, who realise the need for active participation of learners in the classroom and in the outside world. Learners, and children in particular, don't

want to sit passively listening to a teacher for hours about a subject which they may struggle to relate to. Many of us have experienced ‘death by PowerPoint’ referring to the monotony of staring at slideshows of text, which slowly numbs the senses and encourages our minds to wander. This is known as ‘dissociation’ - the creative mind will often daydream and begin to visualise and imagine something which isn’t there Daydreaming is the stream of consciousness that detaches from what is taking place in the real world and attention drifts to an individual’s inner thoughts. The term was conceived by Jerome L. Singer and is sometimes referred to as spontaneous thoughts, mind wandering, or even fantasy (Dresang and McClelland, 1999). A large-scale scientific study revealed that 47% of the participants’ time awake was spent daydreaming (Killingsworth and Gilbert, 2010). With advancements in technology, our daydreams can now be brought to life, and we have the potential to view and interact with our wildest dreams and fantasies.

Augmented Reality (AR) has been described as the greatest tool of our age and Steve Mann, Chief Scientist at Meta Company, described AR as being ‘as important as electric light and may well be the most important invention over the last 5000 years’ (Peddie, 2017:15). If we can imagine it, then we have the ability to create it in AR form, and place it into the real world in front of us. Instead of learning about dinosaurs in a history book, we can digitally generate a life size dinosaur in our own space and examine every aspect of its form (Aukstakalnis, 2016).

With the use of AR, individuals can now interact with content, places and spaces in new and exciting ways and as mobile devices become even more prevalent in society and powerful smartphone technology improves, access to AR will become easier than ever (Parsons, Inkila, Lynch, 2019). Children as young as 3 years old are being given their parents old smartphones and this digital native generation is now ready for new ways of learning Our children who have been born into this digital age speak the language of tech, it is their frame of reference and their mind-set (Prensky, 2001). My hope is that by tapping into the digital generation’s connection to technology that they will enthusiastically engage with my English Heritage project, and it will encourage more individuals to go outdoors to connect with nature and the rich heritage of our nation.

For this research, a Google survey titled *‘Can Screen Time, Encourage Green Time? When Nature and Tech Connect’* was shared with fifty participants aged five to eighteen years. 54% of the participants were five to nine years of age and 38% were ten to 14 years of age. Of the fifty responses received, 94% owned their own mobile phone, iPad or games console and 86% had daily access to it. Mobile devices were used for a range of activities (figure 1) but the most common responses were for watching YouTube and for playing games. This information encouraged me to

consider these two main features of film and game play when developing my project and subsequent decisions in the field.

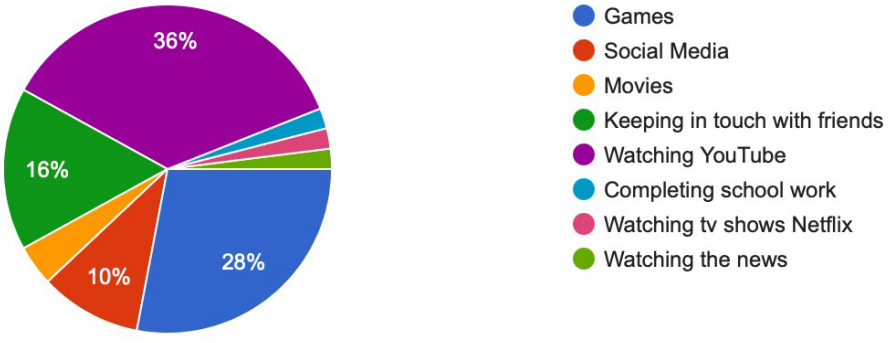

Figure 1: Survey responses for "What do you mostly use your phone/iPad/console for?'

The majority of those children surveyed disclosed that they spend between two to five hours a day on their devices, with 12% of those surveyed admitting to spending five hours plus on tech. Without limitations, almost 50% of the respondents stated that they would like to spend five hours plus on their gadgets. These findings supported my fears that this digital native generation are addicted to their tech, and some would happily spend up to half of their waking hours fixated on their screens. 90% agreed that technology probably makes them less active, and they expressed some of the negative effects of spending too much time on tech such as headaches, sore eyes, feeling ill and tired. Considering some of these answers, I was encouraged to believe that developing an app to encourage families to go outdoors would be a positive way to aid towards reducing sedentary behaviour and to entice healthier, more active lifestyles. 94% of the children surveyed stated that they did enjoy being outdoors in nature and listed some of the benefits as having fresh air, improved physical and mental health, vitamin D from sunshine, greater activity and more fun.

Although many of the children surveyed had not heard of Augmented Reality, 92% agreed that they would like to see the myths and legends of an area brought to life by seeing dragons, mermaids and wizards etc. appear in front of them on their mobile device. The majority also thought that using AR like this would perhaps help them to understand more about the location and the history of the area (see figure 2).

The survey also highlighted that most participants already used digital game-based learning in school and 96% felt that they would or might prefer to learn outdoors rather than inside a classroom. 76% of the children surveyed stated that they could not remember a time in life when they did not have regular access to digital technology and 94% believe that they learn a lot from regular digital

interaction. Participants were also asked to watch a short, Augmented Reality video created by Magic Leap and 98% of the children agreed that they would be excited to see more Augmented Reality. These results were highly promising for my project with English Heritage. Lastly, the survey participants were asked to think about how technology might be used in fifty years' time. There were some wonderful answers including discovering aliens, to make robots that will do everything for us, to bring dinosaurs back, to build houses on the moon, to be implemented into our bodies, to teleport and to speak with animals. These answers exhibit how this digital native generation is imagining huge developments with technology within their lifetimes.

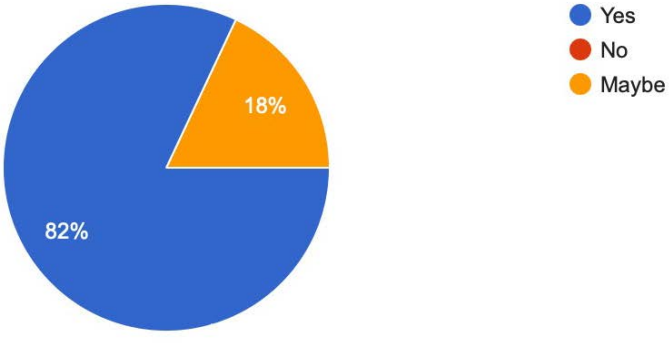

Figure 2: Survey responses for: Do you think it would help you to understand more about the location and the history of the area?

As my career in art and design has required me to engage with new technological advancements, I have been overwhelmed, frightened and in awe, all at the same time. I'm blown away by what we can now achieve regarding Augmented Reality but scared at what the future might hold for my children who are already addicted to their glowing screens and becoming less engaged in the real world. But AR is now a mainstream reality and so here I am, looking at the many opportunities that AR can offer and discovering ways of increasing engagement in the outdoors by using the lure of technology (see also: Kumpulainen *et al.*, 2020 on *Children's augmented storying in nature*).

So, what exactly is Augmented Reality? AR tech brings computer-generated images, sounds, and other elements together in real time, to enhance the user's interaction with their domain and to create a more immersive experience. The British Computer Society (2021) defines Augmented Reality as 'combining the digital world with the physical one and therefore augmenting the real-world experience'. This combination of real and virtual content has opened a whole new world of learning for individuals and the interaction that they have in indoor and outdoor settings. The computer-generated virtual content can be almost anything – 3D

models, videos, web content – and it can be triggered by a location, or by an image marker or a combination of the two.

Medical students can now view virtual anatomical structures such as the heart in a real patient's body (figure 3), advertising and marketing can be viewed in completely new ways, architects and product designers can show virtual buildings and objects in real world spaces… the possibilities right now seem endless. This predisposition that we have as humans to 'create' is what fascinates me. As technology has evolved, 'the human race has managed to bring sci-fi elements into reality in a few short decades' (Designing Digitally, 2021).

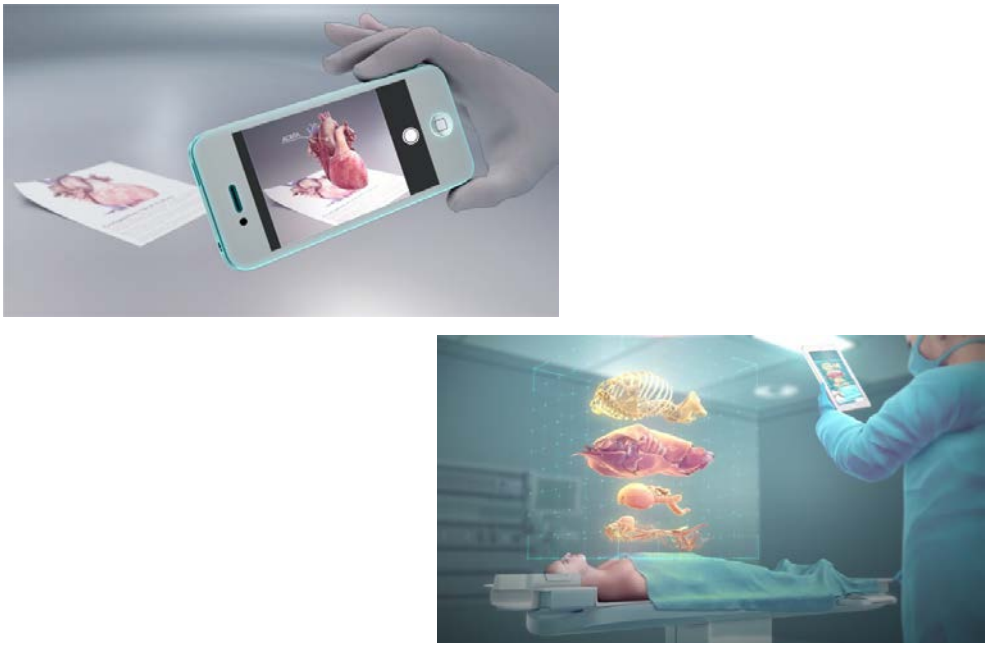

Figure 3: AR being used to study anatomy and physiology in medical training

Augmented Reality is different to Virtual Reality (VR) technology which fully immerses an individual in a computer-generated environment. With VR, one doesn't need to leave their room in order to experience what it is like to look out from the summit of Everest, or to board a spaceship or to walk through a forest full of dinosaurs. Whilst this prospect may be appealing to many, AR has a much greater potential to reduce sedentary behaviour which is often associated with using technology for extended periods of time indoors. AR and VR can be placed on Milgram and Kishino's (1994) virtuality continuum (figure 5) that arranges computer interfaces according to how much of the user experience is computer generated. On the left of this continuum is the real world with no virtual information, whilst on the opposite end of this continuum is VR, where the users entire experience is computer generated. Everything in between this is mixed reality.

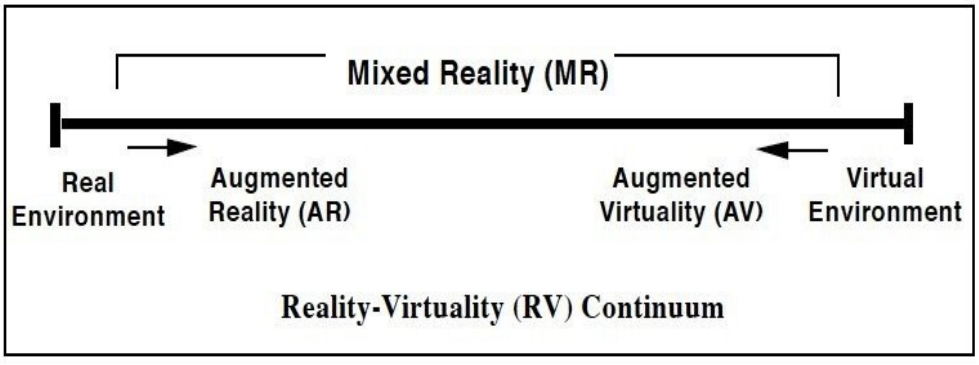

Figure 5: Milgram and Kishino's Mixed Reality on the Reality-Virtuality Continuum (Milgram and Kishino, 1994)

There are a variety of benefits of using AR but some of the key strengths are that it can provide a richer user experience by increasing engagement and interaction and it is hugely accessible with the rapidly growing smartphone market. The use of AR is currently growing across many industry sectors including, automotive, consumer retail, education, financial sectors, publishing and tourism and heritage.

Since the story of AR began back in Harvard in 1968, with Ivan Sutherlands first head-mounted display, huge leaps in development with ARToolKit, Google's Google Glass and Microsoft's Windows Holographic and HoloLens are paving the way for incorporating this technology into our everyday lives. Engine Creative (2021), a world leading Augmented Reality campaign provider, claim that AR engagement is up 20% since the beginning of 2020 and right now it is one of the fastest growing industries in the world. Mindshare.com (2021) claims that AR is three times more memorable compared to non-AR media.

The first commercial AR application was developed in Germany in 2008 for a marketing campaign for BMW that allowed users to interact with a digital model in real time. Other brands started adopting the idea of using AR including National Geographic in 2011, when they were able to bring extinct animal species to virtually walk through a shopping mall (figure 6). Disney the same year showed characters on a large screen in Times Square interacting with a crowd, and Coca Cola, in 2013, began educating on environmental issues by simulating melting ice caps using AR in a shopping mall (figure 7).

In each of these cases, AR was used in public spaces to help to engage and connect with an audience, just like the 2015 Skoda campaign at Victoria railway station in London that used an AR mirror to allow people to customise a car to their liking, and then to see themselves on the big screen driving it.

Figure 6: AR being used in National Geographic campaign

Figure 7: Coca Cola, Melting Ice Caps campaign

AR can also be used as a valuable training tool as it has the power to make complex subjects easier to understand by allowing users to access virtual material that could support them in a learning-by-doing/viewing method. This could open a whole new world of medical training, engineering, computing etc. There is also a rich body of research that suggests AR can be incredibly valuable for exploring historical, cultural and geographic aspects of the environment, for example see: Beetham and Sharpe (2013), Holloway and Mahan (2012), Huang, Chen and Hsu, (2017) and Shark (2015). This was inevitably the area I wanted to explore further so that I could bring my love of the outdoors, cultural heritage, education and design together in one exciting innovation project.

Apps developed for tourism first started to appear in the 2000s (Javornik, 2016) but it took years of technological advancements to get them from the development stages to being more widely used as they are today. Understanding the consumer experience was also an important part of the development of these apps. There are many apps designed for museums that allow visitors to access further information about artefacts and paintings by holding up a smartphone screen close to the object whilst using the app and it will overlay a description or play a video in real time. The Museum of London has produced an app that allows users to view how a street once looked in the past by holding up a phone camera and then the augmented version appears on the screen (figure 8). Similarly, Google Sky Map allows users to point their phone camera towards the sky in order to identify certain planets and stars (figure 9). Google have also produced the useful app Google Translate which will instantly translate text when you point your phone camera at it.

Figure 8: Museum of London app

Figure 9: Google Sky Map

When deciding upon the content and focus of my research, I knew that I first wanted to develop an app based on the heritage of a location but to use the magic of AR to bring the myths and legends of Great Britain alive for children and families to enjoy together, in the outdoors. The location of my protype project was always obvious to me, the breath-taking site of Tintagel (figure 10) with the associated legends of King Arthur.

Figure 10: Tintagel (photo: private collection, Susan Thomas)

I'd been there many years ago and the coastal landscape surrounded by crashing waves, and an air of mystery had never left my thoughts. It is one of only a few places in the British landscape where you can see the foundations of early medieval houses, but it is the legends of King Arthur that brings visitors from across the world.

The site, owned by English Heritage, is described by them as a place to 'immerse yourself in history, myths and stunning scenery' (English Heritage, 2021) and 'for centuries this dramatic castle and coastline has fired the imaginations of writers, artists and kings'. It certainly does inspire the imagination of creatives like myself, and I hoped that I would be the first to produce a project proposal for the charity using the technological advancements of AR. On the island you can explore the remains of the 13th Century castle and the ruins of the Great Hall whilst also exploring the main site which is a place of Special Scientific Interest (SSSI) - home to plenty of flora, fauna, wildlife and coastal birds.

Occasionally, seals can be seen in the waters around the coast... and who knows, perhaps even mermaids will be making a virtual appearance soon!

Myths and legends such as that of King Arthur are a form of storytelling which is common to every culture and has been around since the beginning of civilisation. I wanted to bring the legends of King Arthur to life by using the captivating power of AR to portray storytelling in a whole new light. As a visual learner, my mind has always wandered when reading masses of text and I can often re-read the same page two or three times before really digesting any information. However, if I see something in visual form – a painting, a film, a show, a picture – they can be etched into my memory forever and can be recalled in a split second. This is what made AR so appealing to me. The idea of unlocking historical myths and legends in visual form and being able to bring them into our world was such an exciting opportunity to draw together narrative, new technologies and time spent outdoors.

Myths and legends are not straightforward as they are generally passed down from generation to generation by word of mouth and over time they can change and hold different levels of significance with various people and cultures. Legends usually contain elements of truth based on historical facts but with 'mythical qualities' involving heroic characters, magical locations and often encompassing spiritual beliefs. Myths tend to be stories based on traditions or legends with a deep symbolic meaning. 'A myth conveys a truth to those who tell it and hear it, rather than necessarily recording a true event' (Wood, 2005:iv). Sometimes, myths may once have been accounts of actual events but over time they can be transformed by place and time or for symbolic significance. Often, myths will be used to explain universal events and may contain heroes or supernatural beings. This provides the opportunity for some wonderful AR narratives which can be balanced with a combination of fact and fiction.

Folktales are another form of storytelling which tend to comprise of fairy tales, old legends, fables and urban legends, also passed verbally from generation to generation. Often, myths, legends and folktales will overlap – with historical facts at

one end of the continuum and cultural folktales at the other (figure 11). It is said that as one draws closer towards the mythical end of storytelling, people become more invested in what the story symbolises to them, rather than the historical facts (Juzwik, Nystrand, Kelly and Sherry, 2008). The story almost takes on a life of its own, so much so that the original event, if there really was one, becomes almost irrelevant. It is often the message behind each story that is truly important and why people choose to believe it.

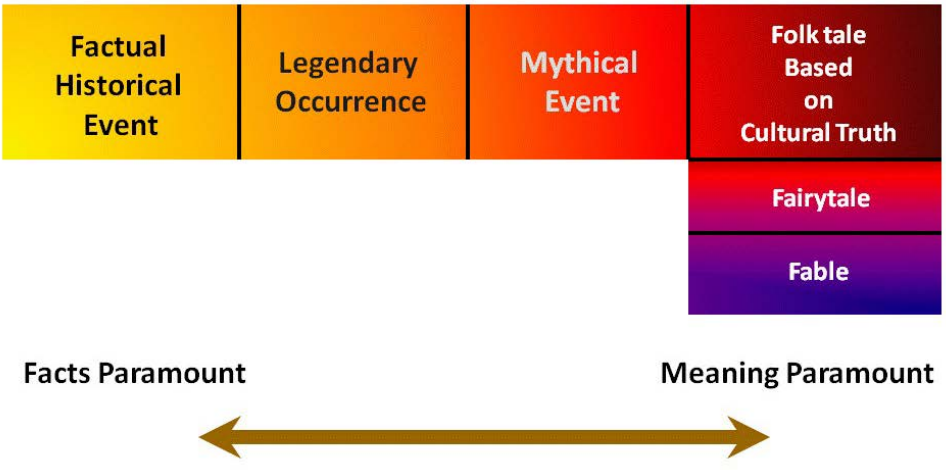

Figure 11: Oral Narratives Genres Continuum (Juzwik *et al.*, 2008)

The more I read about the legends of King Arthur, the more I realised this to be true (e.g. Courtauld, 2014; Seddon, 2013; Batey and Holder, 2019). Although I initially thought it would be easier to tell a story that had a defined narrative filled with historical accuracies, the myths and legends were actually a more appealing option for using AR as it gave me the freedom to be able to bring in mythical creatures such as the dragon and the unicorn for capturing the attention of a young audience. In fact, myths and legends became the perfect, creative subject matter for the AR innovation project as potentially the narrative could contain the most magical stories recorded from this magical part of the Cornish coast. Merlin could create wondrous potions in his cave whilst dragons soar across the sky and mermaids could swim through the ocean whilst unicorns gallop across the shores.

After decided upon using AR as a form of storytelling, I came across a multi-disciplinary project that was based on the David Almond archives at Seven Stories - the National Centre for Children's Books in Newcastle upon Tyne. This fascinating project combined archival research, Augmented Reality technology, Almond's magical realist writing and experimental workshops to explore whether AR can enhance young people's engagement with archives and literature (Reynolds,

Schofield and Trujillo-Pisanty, 2020). What was interesting about this project was how it highlighted the extent to which Almond's fiction is itself a form of augmentation that represents a particular geographical location - the Northeast of England - in ways that challenge official accounts of that place. Their research project was conceived in response to a challenge by UK research councils to demonstrate how the arts and humanities can inform the development of new immersive technologies. Their project, which also aimed to increase access to the use of the assets of cultural organisations was titled 'Children's magical realism for new spatial interactions: AR and archives'. A series of 6 workshops were devised by Newcastle University's Culture Lab (research in creative digital practice), researchers from the Literature Unit and members of the Seven Stories creative events team. In these workshops, Seven Stories staff, local app developers, teachers and children between the ages of seven and fourteen came together in the development of an interactive smartphone app, called Magical Reality. The project used technology with children's literature to find new and exciting ways to tell stories about places and their links to the past. David Almond can be seen in figure 12 with a mural from the interactive art trail, *Winged Tales of the North* (Kate and Co, 2021).

Figure 12: David Almond: *Winged Tales of the North* (Kate and Co, 2021).

The Magical Reality app uses AR technology to place digitally generated objects constructed from sketches and notes from David Almond's work (figure 13). The app is used on a smartphone along a specialist trail at the visitors' centre and a series of prompts encourage the user to point their phone in certain places for a magical realism item from the David Almond archive to appear and move within the space. It was a very successful project and experimental engagement was noted as being very high as the participants explored the trail using the app. There were some health and safety concerns due to participants using the app whilst crossing roads etc. which needed to be addressed. This is also a concern of my own, particularly with the location of my Innovation Project on a coastal heritage site. Safety would be imperative for the AR app to be used, particularly near to any cliff edges. This had previously been covered in the risk assessment devised for the EH project.

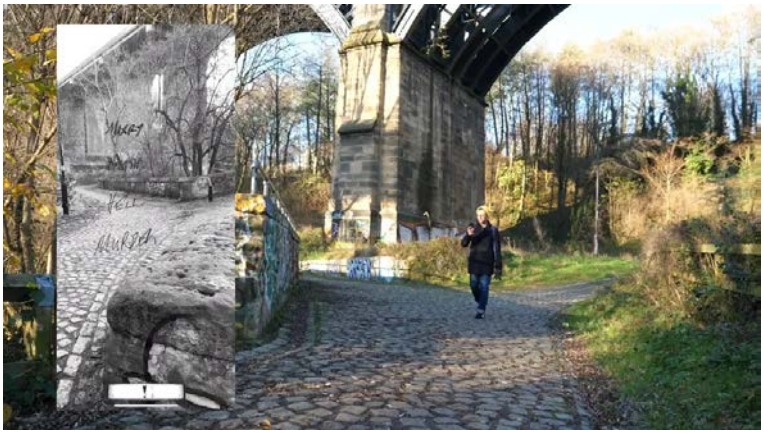

Figure 13: Research volunteer using the Magical Reality app

The Magical Reality workshops and project development paid homage to the more culturally meaningful uses of AR. As described by Liao and Humphrey's, (2014:2), AR digital projection can be used to incorporate sounds and stories at historical sites that may have been absent in official accounts, 'changing how these sites are understood and whose stories they tell'. In Almond's work, AR highlighted the stories, experiences and voices left out of some longstanding representations of the region and displayed how his writings 'augment' the spaces, places and memories which feature in his fictional work. The connections between this magical realist writing and AR and how the two forms complimented each other felt promising for the development of my AR app based on myths and legends at heritage locations. AR has so much potential to engage young people by developing stories grounded in history but also adorned with magic and fantasy.

The more I read about the inspiration for David Almond's work, the more I began to draw parallels with the site of Tintagel…'Its architectural remains and physical legacies litter the landscape alongside more picturesque evidence of Roman occupation and early Christian activity' (English Heritage, 2021). This backdrop, 'ancient and modern, romantic and decrepit' would provide rich opportunities for interactive learning. Myths and legends often have strong links to particular landscapes and places, making them the ideal narratives to help younger audiences develop a sense of how the past shapes the present. As AR continues to develop it will find its own ways of storytelling but until this technology is developed to its full potential, there is so much to be gained by cultivating the relationship between AR, heritage and literature, to fill in the gaps and to animate historical sites.

Alex McDowell, an award-winning production designer, has been creating imaginary worlds for many years with films such as *Minority Report*, *Lawnmower Man* and *Fight Club*. As the director of the USC World Building Media Lab in Los

Angeles, he researches the future of storytelling and the use of mixed reality. During a 2-hour video call with Alex, he described to me how he believes that the process of building worlds can inform and inspire stories and how the process of storytelling is evolving from verbal tribal legends with singular viewpoints, to immersive experiences with multiple perspectives. It is his belief that as AR becomes more multi-disciplinary over time, then the more profound these experiences are going to become.

As work on the Innovation Project began, a list of possible names for the AR feature to be used at the English Heritage sites was devised. The name *Enlighten Project* was eventually chosen as the meaning of Enlighten is to 'give (someone) greater knowledge and understanding about a subject or situation' (Oxford Dictionary, 2021). For me, this was what the project aimed to do. Present history in new ways, engage individuals in the legends of the area and provide the opportunity for visitors to leave the heritage site with a greater knowledge than when they first arrived. It was important that the logo worked well with English Heritage's current logo and so after studying their branding guidelines and spending several weeks on the logo development, I finally came up with a design that encapsulated everything I had imagined. I knew it would lend itself well to being animated for the promotional film piece that was produced (see YouTube link at the end of the paper) and it adhered to English Heritage's two-colour scheme (black and red) for the vast array of printed materials. Even as a stationary, the 2D logo was designed to encapsulate the notion of three-dimensions, motion and interactivity (figure 14).

Figure 14: The Enlighten Project Logo (by Susan Thomas)

The Enlighten Project for English Heritage was built upon the premise of six underpinning attributes for learning (figure 15). These being:

- Integrated use of mobile AR technology
- Collaborative family interaction
- Cross subject learning
- Game based learning
- Outdoor Learning
- Open Education

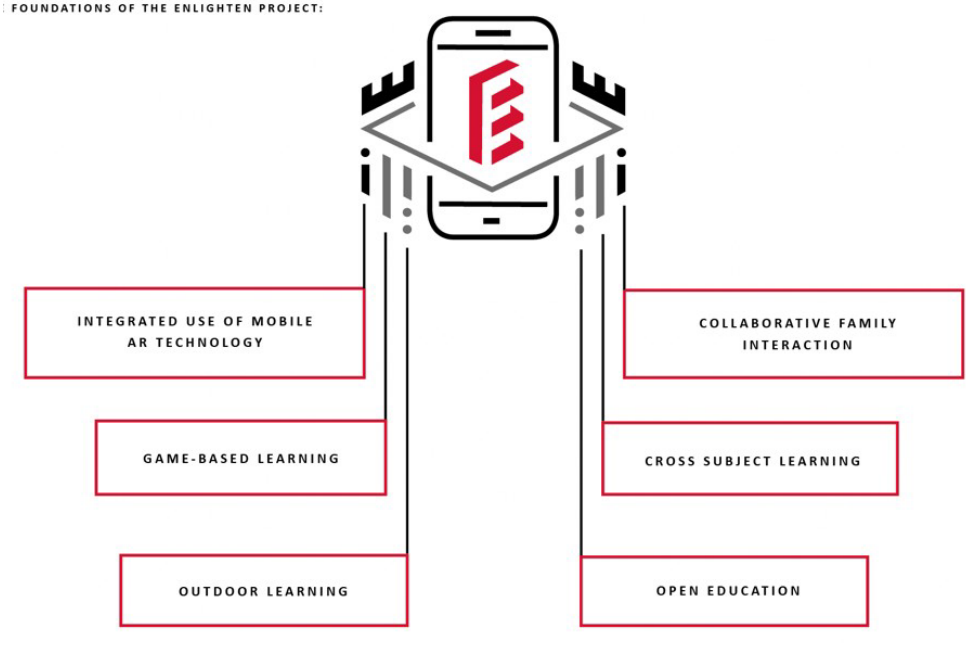

Figure 15: The foundations of the Enlighten Project to aid learning

By using mobile devices with AR technologies, it is possible to place learning at specific English Heritage sites in a relatively inexpensive way. By creating the Enlighten app, visitors to each site would be able to access virtual information and become immersed in the myths and legends of the area in a compelling way. Mobile devices allow for informal learning anytime and anywhere. Outdoor learning allows for fun and informal learning to take place, combined with the benefits of being outdoors and all the things associated with a more active and healthier lifestyle. AR in support of outdoor learning is perfect for cultural heritage tourism.

The Enlighten feature of game-based learning is to involve participants in the Quest to find a collection of vibrant virtual treasure discs which represent significant features from the Legends of King Arthur, i.e. the narrative in each area of the site for example, see figure 16. This would help to provide motivation and promote engagement for the younger visitors. These virtual treasures would allow participants to score points and a small prize (perhaps a pin badge) could be awarded to each treasure seeker at the gift shop. For further interaction, questions could be added along the route to increase discussion and engagement within families.

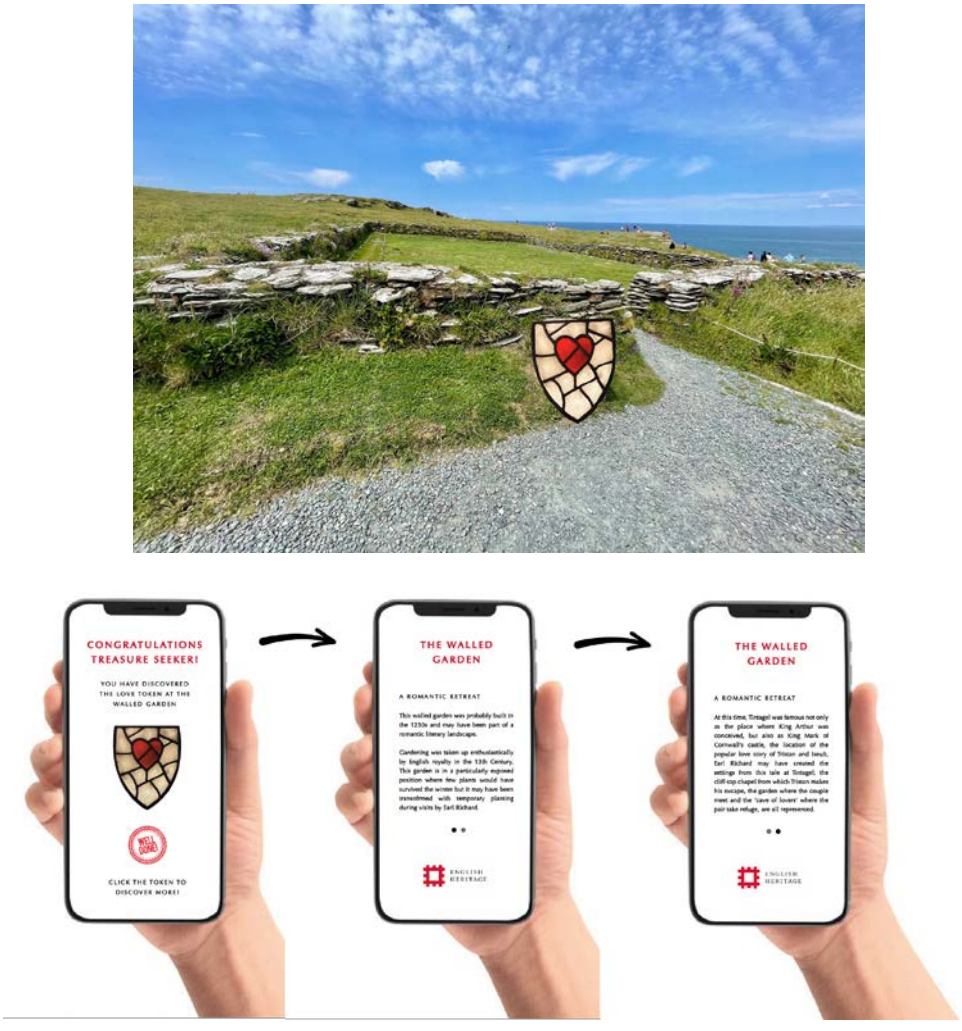

Figure 16: A scanned AR treasure at the walled garden

Each of the virtual treasures pay homage to Veronica Whall's 72 stained glass windows at King Arthur's Hall of Chivalry, built at Tintagel in 1929 (figure 17).

Figure 17: Some of the Quest Treasures

This leads on to collaborative family interaction and engagement. Educational games and challenges at each heritage location around the Tintagel site would promote discussion and teamwork. Also, making the app widely available for all would provide access to learning in historical spaces to a wider target audience. The app would of course be limited to those with a mobile phone, but smartphones are becoming more commonplace in today's technology-driven society. The Enlighten Project is also designed to encourage cross subject learning. History, visual arts, biodiversity, geology, cultural issues… there are many diverse subject areas that are covered when spending time at a heritage site and visitors could potentially establish new connections with their environment.

Thorough analysis of the legends of King Arthur and the site of Tintagel led me to create a storyboard encapsulating key events, characters and mythical narratives to assist with the development of the Enlighten app, along with the promotional film piece. Mythical creatures were included in line with the legends, along with digital paintings of these assets, created using new technologies (iPad and Apple Pencil). Trials using AR then took place at a variety of outdoor settings.

Initial experimentations using the AR dragon were conducted in the local park using Google AR. These 3D models and animations are possible thanks to Google's platform ARCore which enables the camera on a mobile device to sense its environment and to interact with the information it is receiving. It is a miraculous piece of technology and the one that I have been most impressed by during the last two decades that I have spent working in digital design.

ARCore uses three key capabilities to integrate virtual content with the real world as seen through the camera of a smartphone:

- Motion tracking allows the mobile device to understand and track its position relative to the real world.
- Environmental understanding allows the device to detect the location and size of all types of surfaces around it.
- Light estimation allows the device to estimate the environments lighting conditions in real time.

Essentially, ARCore tracks the position of the mobile device as it moves and builds its own understanding of the real world (Google, 2020). It is the motion tracking that allows you to move around and view the objects (in this case the dragon) from any angle.

The image below shows how ARCore worked out the necessary shadows needed for the dragon flying over the coast at Tintagel (figure 18).

Figure 18: AR Dragon over Tintagel coastline (Photo: Susan Thomas private collection)

On location personal reflection

Walking on the path down to Tintagel, I was excited and apprehensive. Would the AR dragon work on location? Would it feel safe for us to use at a coastal heritage site? How would it work with lots of other tourists sharing the space? So many thoughts were racing through my mind as the sun shone down on us and the kids ran ahead excitedly ready for 'mummy's big project' which my husband had now humorously named 'Wow Wee Historeeey!'.

It still makes me laugh now thinking about the conversations we all had in the car journey down to Cornwall and I loved how the whole family got onboard with the project. George, my now 9-year-old son, wanted to know everything about King Arthur's tales and the history of Tintagel and his engagement was much higher than usual. This was mostly because he knew it was an important research project for me, but he was also elevated at the thought of whipping out the iPad whilst on location and seeing the AR dragon come to life. He'd enjoyed the previous summer experimenting with the AR animals, and it generated an added thrill to the average day out where, in his words, 'we have to walk round for hours just looking at the scenery'.

Although I still live in hope that he will one day appreciate the view alone, I was glad of his enthusiasm to reach our location knowing that there was something in it for him so to speak. I realised that the AR addition to the heritage site was almost an enticing bribe like the offer of an ice cream after completing a long walk on a hot summer's day. Is that what I was creating? A bribery to relieve kids' boredom whilst their parents enjoyed a cultural day out? I hoped not... although there are always three sides to every coin – the good, the bad and the ugly. It reminded me of my everyday battle of being immersed in the love/hate relationship I'd formed with technology throughout my career.

As we walked up onto the mainland, there was no buzz of technology around us, just the tweeting sound of the birds and a heightened feeling of excitement to be there at the home of King Arthur. The site was even more breath-taking than I had remembered, and I felt in awe of the stunning cliff top scenery. Looking at the ruins of the castle and the vast blue sky against the sea, I realised just how magical AR could be here. To view the magnificent castle as it once would have stood imposingly on the land and to watch a dragon soaring across the sky... it had the most incredible potential.

As a visual learner, I felt I could very quickly present the story of the land in a way that would be memorable, and I began to think how sound could be incorporated at certain points along the AR trail. I imagined the clattering of pots being unloaded from the ships and being brought up to the Great Hall.

As we came towards the bridge spanning the 190-foot gorge and viewed the panoramic sea views leading into Merlin's cave below, it seemed like the ideal time to trial the AR dragon in the sky above us (figure19). Wow! It did not disappoint! As the majestic beast soared above us, his giant wings flapping and his gentle roars filling the air, small crowds began to gather around us, fascinated by what they could hear. As they saw my children's delight in the dragon's presence and listened to the laughter and roars, intrigue around us grew and everyone wanted to see what was happening on the screen of my smartphone.

It was a delight to share my project with those around us and the general reaction was 'Wow! Fascinating!'. These happened to be the exact words used by Dr Matt Thompson, Head Collections Curator at English Heritage (English Heritage) who was also excited to hear about the project. Over email dialog we have discussed presenting the project to the English Heritage technical development team and I discovered that there had been previous plans to begin AR development work in 2020, but everything was unfortunately put on hold due to the Coronavirus Pandemic (March 2020 to summer 2021… and continuing…).

Figure 19: The AR dragon flying above us

(Photo: Susan Thomas private collection)

The Enlighten app was also designed to serve as a fun interactive game as well as a learning tool. Mobile devices are often considered to be a distraction or disruption from learning, whereas being outdoors is often associated with leisure time and not learning. The hope was that my app would combine mobile gaming and authentic outdoor learning and perhaps go some way towards changing attitudes towards the use of tech outdoors. Mobile devices are familiar to the digital native generation and so using these gadgets as a learning tool to encourage individuals outdoors seems to be a positive solution. These kinds of tech can motivate young families, facilitate learning in outdoor environments (Cooper, 2005), and encourage families to reconnect. It has been suggested that game play can be highly motivating to participants (Wong, 2017; Lin, *et al.*, 2018) and if designed carefully can really engage and promote learning (for example see: Makoe, 2012; Roussou, 2004; Pombo and Marques, 2020).

The aim of the Enlighten Project is also to change mentalities about how people can informally but authentically learn using mobile technologies and at the same time enjoy the outdoors and all it has to offer. Children only spend 20% of their waking hours in school and so looking at how playful, informal learning can be used to educate individuals the other 80% of the time is definitely worth considering. AR has the potential to foster learning and engagement in a unique and exciting way. Wu, Lee, Chang and Liang (2013) addresses the requirements of an Augmented Reality system to foster active learning. These criteria are that it must be fun, challenging and stimulate curiosity. If these criteria are all met, users should autonomously develop their own learning of the subject e.g. heritage and legends, in a meaningful manner.

As our day continued around Tintagel castle and I banked enough photographic work and film to occupy my evenings for the next three months, I again began to have mixed feelings about the project. On the one hand, I deemed the Enlighten Project demo at Tintagel a huge success due to the positive feedback from English Heritage, family, friends and spectators on the day. However, I still had doubts that I was somehow facilitating something that I wasn't 100% comfortable with doing. The disparity between nature and tech is so glaringly obvious… was it misguided for me to try to make them connect? This was comparable to the yin-yang relationship with analogue and digital throughout my career in design, mother earth and that digital demon, tech versus the great outdoors - I'm still establishing my feelings for technology on a daily basis. Could they coexist happily together? There was a niggling feeling that our day out at this spectacular location had somehow been tainted by holding up mobile phones and iPads throughout the day. It was hard to ascertain whether this was my own genuine feeling or whether it was connected to the stigma in society of spending too much time on tech, particularly at a beautiful and picturesque location.

In some ways, I could rationalise and justify the use of a smart device, as being a keen photographer. I have always spent my time hiking, exploring, travelling with a device in hand. It had become an extension of my essentials kit when I left the house – water, snack and a camera - now integrated into the convenience of a mobile phone which also has the benefits of a location finder. But part of me still longed and craved for the simpler days when children ran around freely allowing every second of the experience outdoors to infiltrate their senses. Sea air and sunshine being the drugs to lift one's spirits and the addictive buzz of technology being hidden away like a monster in a cave. Perhaps this inner battle will forever be present and only continued research, creativity and innovations will find solutions for nature and tech to sit harmoniously together.

One possible way to overcome the self-condemnation of taking a mobile device constantly in and out of one's pockets would be to wear a head mounted display designed in the shape of a pair of glasses such as Google Glass (figure 20). For someone such as myself who already wears glasses, a lightweight wearable computer headset would feel like the most unobtrusive solution to be able to view AR in and around a location. Originally designed by Google X, this idea of a ubiquitous computer (where computing is made to appear anywhere and anytime) displays information in a smartphone-like, hands-free format. In May 2019, the newest version of Google Glass, Enterprise Edition 2 was launched. Wearers were able to communicate with the internet via voice commands and it allows for AR content to blend more seamlessly with the real world. If visitors were able to wear these glasses on locations such as Tintagel, and they could view the mythical creatures and historical facts in real time without any disruption, then this could be a highly desirable option.

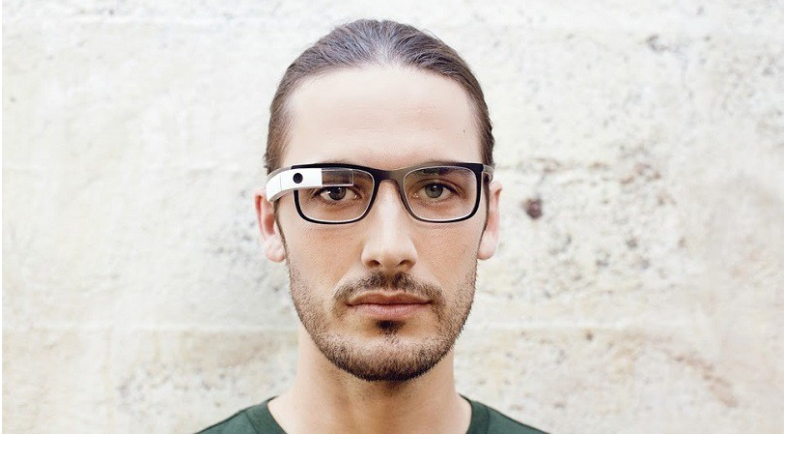

Figure 20: Model wearing Google Glass

AR is constantly evolving with the latest upgrades in technology and over time it could permanently change how users interact with certain products or their environment. The more people begin to expect this from AR technology, the more it will continue to advance and develop and perhaps become highly customised to certain individuals and particular areas. I believe that the key really is to look at how these technologies can be seamlessly weaved into our everyday lives so that they can empathetically enhance activities rather than making everything feel digitised, robotic and automated.

As work continued on the Enlighten app and the brand developed further (figure 21), my worries subsided, and I was excited once more by the way in which the project was evolving.

Figure 21: The Enlighten Project merchandise.

For the promotional film piece for the Enlighten app, hundreds of images were selected from the 2-day visit to Tintagel and these were combined with the AR image captures and videos. The soundtrack to the film piece was to be 'Tintagel' a symphonic poem composed by Arnold Bax (figure 22). Bax was inspired to compose this piece after he visited Tintagel Castle in 1917 with his lover, Harriet Cohen who was a pianist. In 1922 he wrote about the piece stating that he hoped the composition would offer an impression of the landscape of Tintagel and reflect some of the narratives associated to the area. He hoped to impart a sense of drama to interpret

the legends of King Arthur. I hope that my visual narrative which is laid out over the 14 minutes and 30 seconds of the composition is able to do the music justice. The dramatic climaxes work incredibly well with the formidable presence of the dragon soaring across the skies.

Figure 22: Arnold Bax's Tintagel (1922)

Conclusion

Overall, I deemed the innovation project *When Nature and Tech Connect – The Enlighten Project for English Heritage* a great success as I believed I had achieved everything that I had set out to do. I had challenged myself as a designer and outdoor enthusiast to bring together my two biggest passions and this culminated in the development of the Enlighten Project as a future business proposal for English Heritage. It has the potential to encourage a vast target audience of tech enthusiasts to get outdoors and so to reduce sedentary behaviour. And at the same time, Great Britain's fascinating heritage and folklores could be presented to a wider audience,

bringing families together for outdoor learning experiences, which could be enjoyed by all generations. There are of course still concerns for the future regarding the use of AR, particularly for heritage tourism. One of the main reasons AR is growing in popularity is that it offers a fundamentally different entertainment experience. A decade from now though, will AR be the norm?

As it begins to integrate into our lives, will it still be as exciting and entertaining as those initial experiences? It is difficult to determine what the next generation of children will expect following on from this, just to get up from their sofas and to venture outside. Whilst these thoughts may keep me awake at night, the only thing for sure is that we cannot halt technological advancements and for the present time, it certainly feels like AR is 'the next BIG thing'. The potential is undoubtably there, and there are so many further avenues to be explored for using AR in education, mobile tourism and in the great outdoors.

The English Heritage website states: 'Gone are the days when people learned about history simply from reading books. People are increasingly looking for experiences that bring history to life in an engaging way and nothing beats standing on the spot where history happened' (English Heritage, 2021). Visualising history unfold in real time at the exact location where these events once took place could now be added to this statement.

The Enlighten Project at Tintagel can be viewed here:

https://youtu.be/UWOalSjWlvw

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JQRSS Author Profiles

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Reviewer Comments

This paper stimulates timely and exciting prospects for engaging with history, heritage and culture. Our collective relationship with tech is comprised on the one hand, of innovation, excitement and potential, and luddites, uncertainty and fear on the other, with plenty in-between! One thing is for certain, however, tech is here to stay. It has taken on a life of its own within the hitherto stable structures of our lives, and this paper is one of many examples of how we can learn to live *with*, not *against* tech for the purpose of learning and engagement - not least with culture and heritage. The 'yin-yang' analogy is interesting, as this phrase is often used in dichotomous terms, perhaps to describe a love-hate relationship, when in fact the essence of *yin* and *yang* is interrelation and integration, which is precisely what the authors are seeking to achieve with this project. Therefore, far from being a 'bribery to relieve kids' boredom', the development of *The Enlighten Project for English Heritage*, along with its underpinning take-home-message (at least for me), is the importance of reclaiming the senses in learning. We can talk about myths, legends and folk-law (*tell me and I will forget*), we can even show others through traditional imagery and videos (*show me and I will remember*), but this project demonstrates the value of, and the need for, immersion with the phenomenon under study (*involve me and I will understand*). Augmented Reality is perhaps a modern-day technological innovation through which we can appreciate the wisdom of ancient proverbs.