Engaging the Museum Space: Mobilising Visitor Engagement with Digital Content Creation

Ross, C[a]., Gray, S[b]., Ashby, J[c]., Terras, M[d]., Hudson-Smith, A[b]., and Warwick, C[a].

[a] *Department of English Studies, Durham University*

[b] *The Bartlett Centre for Advanced Spatial Analysis, University College London*

[c] *Grant Museum of Zoology, University College London*

[d] *Department of Information Studies, University College London*

Contact:

Claire Bailey-Ross

claire.bailey-ross@durham.ac.uk

ABSTRACT

In recent years public engagement is increasingly viewed as more than an 'additional extra' in academia. In the UK, it is becoming more common for research projects to embrace public engagement with the belief that it informs research, enhances teaching and learning, and increases research impact on society. Therefore it is becoming increasingly important to consider ways of incorporating public engagement activities into digital humanities research. This article discusses public engagement and digital humanities in practice, highlighting how museums are utilising digital technology to engage the public. This article describes the development and presents the results of a case study: The QRator Project, an application for digital interpretation in the Museum and Cultural Heritage sector. The QRator project took an innovative, multidisciplinary approach to creating new ways for museum visitors to engage with museum objects and discussions. The objective was to understand how digital technologies, such as interactive labels and smart phones, create new ways for users to engage with museum objects; investigate the value and constraints of digital sources and methods involving cultural content; and demonstrate how crowdsourced digital interpretation may be utilised as a research source. This article will use the QRator project as a case study to explore how mobile devices and interactive digital labels can create new models for public engagement, visitor meaning-making (Silverman 1995) and the construction of multiple interpretations inside museum spaces. This article will also put emphasis on how public engagement can and should be a core consideration of Digital Humanities projects.

INTRODUCTION

There has been an increasing focus on the role that universities can play in contributing to engaging the public in academic research (see NCCPE 2015). This is emphasised by the Higher Education Funding Council for England, UK[1] which adopted impact assessment as part of the 2014 Research

---

[1] http://www.hefce.ac.uk/

Excellence Framework (REF)[2], of which engagement was an integral part. Public engagement in academia is often described as a 'cluster' of activities including but not restricted to, learning, programs and research which address specific social, economic and political needs (Hall 2010). Since the early 2000s, the term 'public engagement' has emerged as a widely-used and highly flexible umbrella term to encapsulate the increasingly wide range of public-facing objectives, approaches and activities which have become prominent in UK scholarly practice, particularly within science communication. Since this time, academic commitment to public engagement has deepened, and public engagement activities have become more institutionalised and professionalised across a range of academic disciplines.

Although official definitions of public engagement have evolved over time and are varied, the National Co-ordinating Centre for Public Engagement (NCCPE) offers a more general definition of public engagement which is applied across academia or higher education:

"Public engagement describes the myriad of ways in which the activity and benefits of higher education and research can be shared with the public. Engagement is by definition a two-way process, involving interaction and listening, with the goal of generating mutual benefit." (NCCPE 2015).

UCL's founding ethos provides a unique motivation to engage with people outside academia; UCL has a radical tradition of being open to all, and of responding to new ideas, challenges and perspectives. The University continues to see itself as a "Beacon for Public Engagement"[3]. UCL fosters the belief that universities and research institutes have a major responsibility to contribute to society through their public engagement, and that they have much to gain in return. There is a commitment to sharing knowledge, resources and skills with the public and to listening to and learning from the expertise and insight of the different communities with which the university engages. Interestingly the majority of Public Engagement initiatives within universities to date, focus on face to face engagement rather than utilising digital applications as an outlet, despite the

[2] http://www.ref.ac.uk/
[3] http://www.publicengagement.ac.uk/about/beacons/ucl

opportunities digital media provides as a tool for public engagement. Likewise, public engagement has not been a core concern for the Digital Humanities until relatively recently (Prescott 2012).

UCL Centre for Digital Humanities[4], alongside the Barlett Centre for Advanced Spatial Analysis (CASA)[5], and UCL's Public and Cultural Engagement (PACE)[6] have set out to develop the area of digital technology research for public engagement. Digital technologies are being used to integrate digital humanities research within and beyond academia; the involvement of the general public in digital resource creation and design; and the application of digital technologies to cultural heritage. We believe that Digital Humanities as a discipline can learn a lot from cultural heritage institutions utilising digital technology for visitor engagement. The QRator project, in particular, demonstrates that such technologies may be used in an academic context to change the way that scholars interact with each other and make their research available to those outside academia. The QRator project aims to stress the necessity of engaging visitors actively in the creation of their own interpretations of museum collections alongside academic researchers.

The QRator project explores how mobile devices and interactive digital labels can create new models for public engagement, visitor meaning-making and the construction of multiple interpretations inside museum spaces. For several years the Horizon Report (Johnson 2011, 2015) has indicated that Smart Objects and the Internet of Things are the future of digital museums. The QRator project highlights the ability of Smart Objects and is centrally located within the emergent technical and cultural phenomenon known as 'The Internet of Things': the technical and cultural shift that is anticipated as society moves to a ubiquitous form of computing in which every device is 'on', and connected in some way to the Internet (Speed and Kanchana Manohar 2010). The project is based around technology developed at the Bartlett Centre for Advanced Spatial Analysis, University College

---

[4] http://www.ucl.ac.uk/dh/
[5] http://www.bartlett.ucl.ac.uk/casa
[6] https://www.ucl.ac.uk/pace

London (UCL) and is an extension of the 'Tales of Things' project[7] , which developed a "method for cataloguing physical objects online which could make museums and galleries a more interactive experience" (Giles 2010) via means of RFID tags (Radio Frequency Identification) and QR codes, (Quick Response code); a two dimensional matrix which encodes data, in this case a uniform resource locator (URL) reference to an object (Wave 2003). QRator takes the technology a step further, allowing users to take part in content creation on digital interactive labels- static iPads and their own mobile phones: a sustainable model for two-way public interaction in museum spaces. This project links a Quick Response code[8] to a conversation about museum objects where museum curators can give insight into an object background, hence the name "QRator". The QRator project uses iPads installed in the UCL Grant Museum of Zoology and Comparative Anatomy (Grant Museum[9]) to provide a fully interactive experience where visitors respond to questions posed by the curators, contribute to discussions, and leave comments about individual exhibits. Visitors' comments are synchronised with the QRator website (http://www.qrator.org) to allow them to contribute to the continuing discussion away from a museum setting. The application provides each exhibit with a unique identifier (in this instance a QR code, a matrix barcode that embeds information such as text or an URL within a graphic that users can read using mobile devices) which links the physical exhibit with the associated conversations. When scanned these codes allow users to discover information about an object and join the conversation from their own mobile device. The unpredictable, multiple forms of interpretation produced by the use of mobile devices and interactive labels make us reconsider ways in which museums provide information about objects and collections and should also allow museums to become more engaging for visitors.

Museum exhibitions have been transformed by the addition of digital technology to enhance the visitor experience (See Tallon & Walker 2008; Heath & Lehn. 2010 for key examples). Ubiquitous

---

[7] http://www.talesofthings.com
[8] It was found during the project that the scanning of a QR code was not integral to project, but successfully acts as a resource locater for visitor comments. If similar projects were to be implemented in other institutions a range of RFID technologies could be used instead of QR codes.
[9] http://www.ucl.ac.uk/museums/zoology

mobile technologies offer museum professionals new ways of personally engaging visitors with content, creating new relationships between museums and their users. Museums and other cultural institutions have made significant investments in developing and disseminating digital content in the physical museum space to reach and engage users, marking a shift in how museums communicate publicly their role as custodians of cultural content and their attitude towards cultural authority (see Pierroux and Ludvigsen 2013; Kidd 2014 and Museums and The Web conference preeceedings[10] for practitioner led examples). Despite recent technical advances in collections access and interpretation, a number of key issues still remain: specifically does the rapidly changing technological environment provide a more engaging and participatory visitor experience?

The QRator project aims to stress the necessity of engaging visitors actively in the creation of their own interpretations of museum collections. This article presents an investigation into the potential of digital visitor generated content applications in museum spaces to foster visitor engagement. The focus is on the integration of iPhone, iPad, and android apps into UCL's Grant Museum, demonstrating the possibilities for visitor engagement. It will emphasise that in order to develop engaging digital visitor generated content applications, museums must radically trust their visitors. . Although this paper will concentrate on digital technology created for a Natural History Museum, issues of meaning making and co-creation of content between the museum and its visitors through digital technology are applicable to any museum or cultural heritage institution. This article discusses the development and presents the results of the QRator project to date within The Grant Museum at UCL, highlights the design and development of the technical components, infrastructure, and user evaluation of the QRator application and stresses the opportunities and challenges in utilising digital technology to enhance visitor meaning making and narrative construction. Finally, this article seeks to understand what Digital Humanities as a discipline can learn from museums and cultural heritage about harnessing digital public engagement.

---

[10] http://www.museumsandtheweb.com/bibliography

VISITOR EXPERIENCE AND MUSEUM DIGITAL TECHNOLOGY

Museums have undergone a fundamental shift from being primarily a presenter of objects to being a site for experiences which offer visitors opportunities for individual meaning making and personalised interpretations (Falk and Dierking 2000).. There is a growing commitment by museums and other cultural heritage institutions to establish new forms of engagement and participation by providing a myriad of resources that facilitate visitor participation, interaction and learning (Kidd 2014; Simon 2010; Røtne and Kaptelinin 2013; Alelis et al., 2013). Visitors see interactive technology as an important stimulus for learning and engagement (Falk et al 2002; Black 2005), empowering users to construct their own interpretation in response to museum exhibits. Engaged within this immersive environment, museum objects become rich sources of innovation and personal growth (Fisher and Twiss-Garrity 2007). When visitors experience a museum which encourages individual content construction actively, their activity is directed not towards the acquisition or receipt of the information being communicated by the museum, but rather towards the construction of a very personal interpretation of museum objects and collections (Simon, 2010). The unpredictability of multiple interpretative forms created by the use of mobile devices and interactive labels introduces new considerations to the process by which museums convey object and collection interpretation and opens up museums to become a more engaging experience (Naismith and Smith 2009, 248).

Digital technologies have played an important part in enabling the provision of more flexible and tailored forms of information and in providing new forms of interactivity in museum spaces (see, for example, Parry 2010; Tallon and Walker 2008; Kid 2014; Alexander et al., 2013). Digital technologies are becoming more embedded, ubiquitous and networked, with heightened capabilities for rich social interactions, context awareness, and connectivity (Naismith, et al 2005). This, has led to unprecedented changes in the provision of digital museum resources, which are beginning to transform the experience of visiting museums. Digital technologies and their uses within museum collections have until recently been explored primarily from a technical viewpoint,

typically ignoring the impact these technologies can have on visitor learning and engagement (Cameron 2003). Increasingly, museum professionals are moving beyond a focus on the technology to consider the implications on visitor experience and focusing on new ways of utilizing digital technology for object interpretation and visitor engagement (see Tallon and Walker 2008). Nevertheless, measuring the impact of new digital technologies has been identified as one of the most important challenges for museums and cultural heritage institutions alike within the NMC Museum Horizon Report, but for which solutions remain elusive (Johnson et al., 2015).

In the past decade, there has been a growing interest in exploring how digital and communication technologies can be developed to offer visitors a more personalized museum experience (Gay and Spinazze 2002), provide more flexible and tailored information, and to facilitate interaction and discussion between visitors. This flexibility in terms of personalising digital content is a growing trend in museums, exemplified by the European funded CHESS project (Cultural Heritage Experiences through Socio-personal interactions and storytelling) which is using an mixed reality and pervasive gaming approach to personalise a user's visit as an interactive storytelling experience and has been trailed in the Acropolis Museum in Greece, and the Cité de l 'Espace in France (Katifori et al., 2014). Many more museums are utilising mobile technology to aid visitor orientation and wayfinding as well as to offer specific multimedia tours within the museum.   The Tate Modern multimedia tours (Proctor, et al 2003) used location tracking for personalized content delivery; the handheld device includes background information, video and still images that gave additional context for the works on display, and the ability to listen to an expert talk about details of the art work.   In 2011, The British Museum launched a multimedia guide that supports way finding and orientation without relying on location aware technology (Filippini-Fantoni et al 2011) and have been continually evolving their strategy for audio guides (Mannion et al 2016). The Exploratorium has undertaken numerous projects exploring mobile technology within the museum space (His, 2003). More recently Cleveland Museum of Art's Gallery One is transforming how museums can

incorporate visitors' active participation in gallery spaces. Gallery One opened to tremendous acclaim and fanfare (Rodley 2013). A range of digital interactives throughout the gallery space offer opportunities for visitors to participate, including a Collection Wall; ArtLens participatory iPad app; a Studio Play area designed specifically for children; as well as six interactive Lense displays (Alexander et al. 2013). This innovative gallery blends art, technology, and interpretation to inspire visitors to explore the museum's permanent collection. Gallery One is, to date, the only non-science gallery which main focus is to use innovative technology to shift the visitor experience to emphasize engagement, curiosity and creativity. The use of digital technologies in museums has been focused around linear curatorial interpretation, but there has been little incentive for visitors to create their own content.

In general, however, despite the growing interest in deploying digital technology as interpretation devices in museums and galleries, and the substantial body of research concerned with visitor behavior, there is yet to be established a critical discourse, both theoretically and practically, for describing the functional link between the interpretive experience and museum digital technologies. There is preliminary evidence that digital technology can increase engagement with museum collections (Pierroux and Ludvigsen 2013; Proctor et al, 2003; Hsi 2003) and with the physical museum surroundings (Naismith et al 2005) as well as increase visitor confidence, motivation and involvement (Burket 2005). However, to date, no empirical studies of museums utilising digital technology have been undertaken to look specifically at visitor content construction.

DIGITAL CONTENT CREATION IN THE MUSEUM SPACE

The QRator project aims to stress the necessity of engaging visitors actively in the creation of their own interpretations of museum collections, offering opportunities for visitors to consume and create digital content, and empowering members of the public to become the "curators." The Grant Museum is taking a proactive role in developing new audience driven narratives centered on the

museum's collections. The project develops a custom UCL Museums iPhone, and Android application which is available free of charge from the iTunes store and Android market place. QR codes for museum objects, and in some instances whole displays have been created, linked to an online database allowing the public to view "curated" information, and, most notably, to send back their own interpretation and views via their own mobile phone. Unique in the UCL technology is the ability to "write" back to the QR codes. This allows member of the pubic to type in their thoughts and interpretation of the object and click "send" (see fig 2-4 below). Similar in nature to sending a text message, the system has enabled the Grant Museum to become a true forum for academic-public debate, using low cost, readily available technology, enabling the public to collaborate and discuss object interpretation with museum curators and academic researchers. Visitors' narratives subsequently become part of the museum objects' history and ultimately the display itself, via the interactive label system which will allow the display of comments and information directly next to the artifacts. This shift in focus from content delivery to narrative construction can be suggested to be reflecting a societal shift in digital media (Walker 2008), and the internet in general, from static centralized control to user generated content and personalized learning. Personal narratives, interactive dialogues and multiple interpretations saturate the internet and museums need to adapt to visitor expectations to fully enable rich meaning making experiences to take place.

The QRator project utilizes user-centered design principles (Norman and Draper 1986; Nielsen, 1993, 2001; Lowdermilk 2013), by explicitly and actively including users in the development process from the beginning. When studying the users of digital technologies it can be argued that use in context is an ideal method as there is a need to understand the real circumstances in which technology is used so that any problems can be found (Terras et al 2001). Thus to produce mobile technology which is most useful in a museum context there is a need to understand the circumstances in which it will function. The project takes concepts of users, narrative, space, object, location, and as well as the appropriate means of mediating the museum experience via a handheld mobile device into account.

However there are issues to take into consideration. If mobile engagement with museum interpretation can occur anywhere, then how can we track and record the learning and narrative creation processes? If the learning and meaning making is interwoven with other everyday activities, then how can we tell when it occurs? If visitor meaning making is self-determined and self-organized, then how can we measure engagement outcomes? These are difficult questions with no simple answers, yet it is essential to address them if we are to provide evidence of the effectiveness of mobile media for visitor narrative construction and meaning making.

DESCRIPTION OF QRATOR APPLICATION

The main component of QRator is a custom bespoke application that is built for Apple's iOS platform running on ten iPads within the UCL Grant Museum. Each of the ten iPad's contained one of ten current questions (Table 1).

Headline	Question	Explanation
Better the devil?	Is finding a cure for the common cold more important than protecting Tasmanian devils from a contagious cancer which could see them extinct in 20 years?	Vast sums are dedicated to curing minor human illnesses, while relatively minute amounts go to conservation. Devil Facial Tumour Disease appeared in 1996 and has since spread across most of Tasmania. Diseased populations can suffer up to 100% mortality after about a year. Tasmanian devils are the largest surviving marsupial carnivore. Is preventing such a loss to global biodiversity worth less than a few human sniffles?
Conserve or display?	How do we balance the needs of our	Most objects on display are irreversibly damaged by exposure to light, dust and fluctuations in temperature

	specimens and the desires of our visitors?	and humidity. The longer they are on display the shorter they will last. Instead, specimens in storage will last longer without requiring conservation treatment and care; however, visitors would not be able to readily see the specimens. Without specimens there wouldn't be a museum.
Bulldogs or brown hares?	What makes an animal British?	Conservation decisions depend on whether species are native. Fallow deer and brown hares are both protected "British" species, but were introduced about 1000 years ago. Grey squirrels are well known "foreigners", introduced in the 1800s. How long does a species have to be in Britain to be "native"? Does is matter if a species was transported here by humans or naturally colonised?
Humans vs animals	Should human and animal remains be treated any differently in museums like this?	The Human Tissue Act controls how human remains are displayed, used and stored. Museums are working to return historic remains to the nations from which they were taken in the past without consent, and no human material less than 100 years old can be displayed without permission from the individual. No such systems protect non-human animals. Why are humans treated differently? Would a primate display be incomplete without a human?
Real or fake?	Is it ever acceptable	Many museums use casts, reproductions and models in

	for museums to use replicas? If so when?	place of original objects. When is this appropriate? Should objects which aren't "real" be highlighted? What's the point of a museum having a genuine object in store if they replace it with a replica for display or handling? Does spotting a replica make the whole museum less believable?
Pets or wildilfe?	Can keeping pets be justified given their impact on wildlife?	People who say that they are animal lovers are often referring to their pets – it's why people react more strongly to a domestic cat preserved in the Museum than to an endangered tiger. Globally, feral pets and pets wandering from home have hunted many species to or near extinction. Do pets have any positive effects on wildlife? Can these effects ever outweigh the damage? What is the difference between wild and natural?
Too testing?	Every medicinal drug you have ever taken was tested on animals. Is this a necessary evil?	In the process of developing new medical drugs, UK legal regulations require them to be tested on mammals before they are tested on human subjects. The argument is that an untested drug's affect on living organs can only be tested on a living animal, and the risk is too high at this stage to chance on a person. Is this justifiable?
Taboo topics?	Should science shy away from studying biological differences	Studying the differences between people from different parts of the world was common in the past. Now, in more enlightened times, such science has become

	between races?	somewhat taboo, possibly due to the fear that conclusions would be drawn that could be considered racist. Should some topics be off-limits to science, when the potential outcomes are unknown? Is it racist to say that different races are biologically different?
Defining animals.	What do we mean by platypus?	Species are defined based on the description of one or a few individuals. Any other individual is called the same species if it is similar enough to those "type specimens". This is a human definition with no real relevance in nature. How similar can the things we call platypuses, or any animal, be to the original? Are the stuffed, pickled and skeletal platypuses in the Museum still real platypuses, or just representations – like a photo or drawing?
Captive and conserved?	Do animals in zoos have any value for conservation?	A major justification for keeping animals in zoos is that they serve to educate the public about environmental issues. 95% of animals in zoos aren't endangered and very few that are are part of European Captive Breeding Programmes. Can the remaining species act as ambassadors for the rare ones? Do zoos teach valuable lessons, and increase appreciation and respect for the natural world?

Table. 1: Current Question content on Grant Museum QRator iPads between March and November 2011.

The application is composed of four separate view states that automatically transition after a one-minute interval, although can be configured to transition after any length of time. The design of the application mirrors the current wooden museum labels that are displayed throughout the UCL Grant Museum. The question is 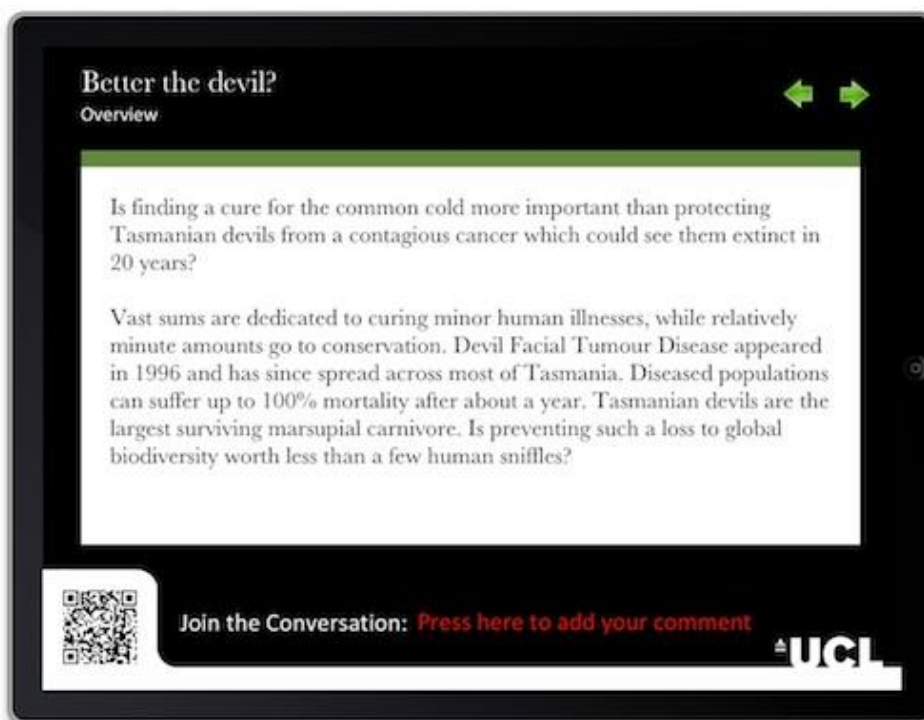framed in a virtual, interactive museum label (Fig. 1) that displays the question presented by the Grant Museum Staff along with a short background of the issue. The design of the application mirrors the current wooden museum labels that are displayed throughout the Grant Museum.

Fig. 1: Interactive Museum Label displayed within QRator application.

At various stages throughout the application, users are invited to interact with the device and contribute to the continuing conversation. The core interactive element of the application is a QR code (Fig. 2), which is prominently displayed in all views, which users can scan with a smart phone using the 'Tales of Things' application, available on both iOS and Android platforms, to record their response to the question asked by the device. During the course of the project, it was discovered that QR codes were not adequately used by visitors (Kasbohm 2012), a common issue that has been

revealed from further user analysis of QR codes (Schultz 2013; Pérez-Sanagustín et al.' 2016) The application allows users to engage with the curators on the iPad through the device's virtual keyboard.

Fig. 2: QR code used to allow users of smartphone app to contribute to discussion.

Visitors' can then respond to current questions posed by the museum, contribute to discussions, and leave comments about individual exhibits (Fig. 3). Visitors' comments are synchronised with the QRator website (http://www.qrator.org) to allow them to contribute to the continuing discussion away from a museum setting. Additionally each iPad is configured with a particular Twitter hashtag (e.g. #qrator), which allows the application to display a list of tweets that visitors inside museum can view and respond to from their own Twitter account via a smartphone. This social interaction allows users to carry on the discussion of the question at a later date.
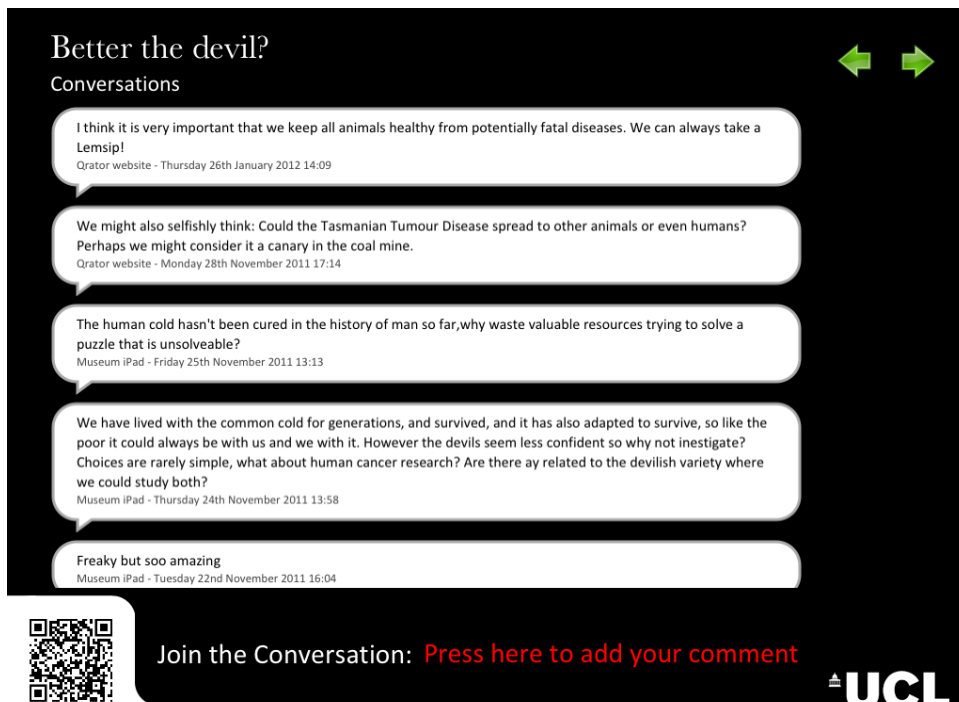
Fig. 3: Visitor contributions to QRator

METHODOLOGY

Data from the ten QRator iPads was collected by archiving contributions from March to November 2011; each individual visitor contribution is simultaneously uploaded to the master database on the Tales of Things website, followed by the QRator website pulling the data about each case label (current question) from the master database and integrates these comments within QRator online. These comments are then aggregated together based on the current questions originally asked by the museum. A custom module was built for WordPress to collect the data from the public API and display the output as a CSV (comma separated values) file (Gray et al. 2012) which was then imported into both Excel and Nvivo statistical analysis packages for further analysis. This resulted in a corpus of 2784 visitor contributions, totalling 29,842 words and 4,496 unique tokens, providing a rich dataset for the analysis of visitor experience.

Visitor contributions were categorized qualitatively using open coded content analysis (Strauss and Corbin 1998, 101-121) where each comment was read and categorized. Contributions were divided

into three basic categories; about the current question or topic, about the museum, or noise. Despite the apparently simplistic categorisation it is possible to discover patterns of use and begin to understand how visitors are relating to and interpreting the exhibitions, and making meaning from their experience.

For the purpose of this study, various quantitative measures were used such as analysing the frequency of comments according to date and time, comparing comment rate between the ten iPad's and suitable text analysis tools were used to interrogate the corpus. In addition, Sentiment analysis was undertaken on the corpus. Sentiment analysis is concerned with the automatic extraction of sentiment related information from text. Sentiment analysis, or opinion mining, is the drawing out of positive or negative opinions from text (Pang & Lee 2008). This type of analysis has been predominately used for commercial tasks, however it is now beginning to be used to detect sentiment for social media texts (Thelwall et al. 2011). The visitor contribution corpus was analysed using a Sentiment analysis tool, SentiStrength[11] developed by Thelwall et al, (2012), in order to automatically measure emotion in the visitor comments, which provides an indication of a positive or negative museum experience.

FINDINGS

The largest proportion of the comments in the corpus fell into two main categories (**Error! Reference source not found.**4); 'about the museum' (42%) and the category of 'on topic' (41%); triggered predominately by the QRator interface and questions posed by the museum curators, suggesting that visitors are inspired to share their own experiences, thus co-constructing a public multiple interpretation of museum objects. The amount of 'on topic' contributions means that 41% of the visitors who left contributors have read at least one of the associated levels of QRator interpretation and felt compelled enough to leave a response. This is mark of the success of the QRator project since this was exactly what the museum professionals had hoped might happen;

---

[11] *http://sentistrength.wlv.ac.uk*)

QRator's main aim, from the museum perspective, was to allow our visitors to get involved in conversations about the way that museums like ours operate and the role of science in society today. We are really interested in what our visitors think about some of the challenges that managing a natural history collection brings up, and other issues in the life sciences. We hoped visitors would engage with, and answer the questions posed by QRator. We hoped that a lot of the questions that were being asked by QRator would be new to them, and that they would be provoked to think about topics they hadn't necessarily considered before (Ashby 2013 pers. comm. 25th November).

Mark Carnall, the Grant Museum Curator[12], goes on to say;

The biggest positive outcome is that visitors are genuinely engaging with the questions that we have asked. Despite the significant opportunities for misuse offered by a post-moderated free-text anonymous digital text box, a huge number of the responses do offer opinionated answers to the questions (Carnal et al. 2013, 64).

---

[12] Mark Carnall was the Grant Museum curator at the time the QRator project was implemented. He was curator at the Grant Museum from 2006 to 2015, he is became the Collections Manager (Life Collections) at Oxford University Museum of Natural History in September 2015.
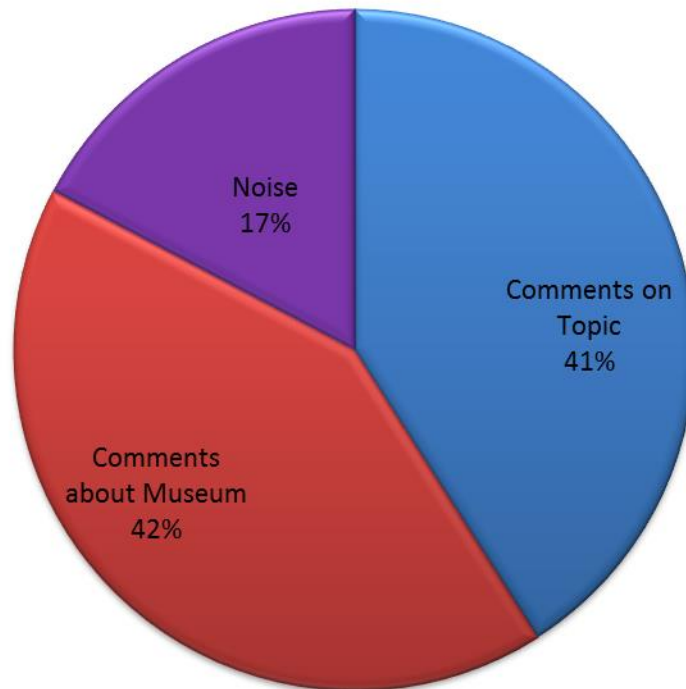
Fig. 4: Percentage of visitor contribution by category. The majority of the comments in the corpus fell into comments 'about the museum' and comments 'on topic'.

Interestingly, many of the visitor comments focused on opinions of the museum as a whole (42%). Visitors are using the iPads, without instruction, to make comments about the museum in general, pointing out what they enjoyed about their visit or making other experience related comments. This type of visitor response raises the question of whether a digital technology used for visitor generated content promotes an opportunity for visitors to make meaning from their whole experience, rather than engage with the exhibit specific content and interpret the exhibitions themselves. These types of 'digital visitor book' comments are now being used by the museum to "inform things we should be thinking about or doing in the future. We are looking at the responses and seeing if we need to tackle specific areas in future events or temporary exhibitions" (Carnal 2011 pers. comm. 26th September). For example the QRator visitor comments have been one source of evidence indicating that visitors to the Grant would like more object labels in the museum space. "We are now in the process of putting a 500- 1000 new labels (depending on how many we can fit in

the cases) out in the museum. That is direct visitor feedback from QRator contributions that we can put into practice in the museum." (Ashby2013 pers. comm. 25th November 2013). This example provides clear evidence that as a result of visitors engaging with the QRator questions, the Grant Museum has changed their museum practice. This is a good indicator of impact.

The lack of spam and inappropriate commenting is surprising (17%). Many museums have been hesitant to open up communication to greater participation by visitors. The concepts of trusting audiences and providing equal participation between museums and visitors are contrary to the traditional ideas of authority, participation and communication in museums (Lynch and Alberti 2010; Ross 2014). There is an ingrained fear in the museum profession that visitors will leave inappropriate comments when there is no moderation or intervention by the museum (Russo and Watkins 2008) despite research showing that museum visitors want to engage with complex, controversial topics by making comments or talking to staff and other visitors (Kelly 2006). The QRator project and the Grant Museum have, however, adopted the concept of 'radical trust' in the visitor community:

> Radical trust is about trusting the community. We know that abuse can happen, but we trust (radically) that the community and participation will work. In the real world, we know that vandalism happens but we still put art and sculpture up in our parks. As an online community we come up with safeguards or mechanisms that help keep open contribution and participation working (Fichter 2006)

This radical trust is based on the concept that shared authority is more effective at creating and guiding culture than institutional control (Lynch and Alberti 2010). Inherent in the term is the suggestion of a previous lack of trust shown by museums towards visitors, but also the admission that such trust is regarded as new and perhaps dangerous. Radical trust as a concept, however is not new, it is widely practiced online in user-generated content, especially by libraries (Lynch and Alberti 2010), and has been previously applied successfully to museum blogging (Spadaccini and

Chan 2007). In practising radical trust, the Grant Museum does not control the final interpretation produced.   The content is genuinely co-created, representing shared authority of a new interpretative narrative that continuously develops with each new audience contribution.   The 'radical' is ultimately a belief in the prevalence of a calm community of participants as opposed to malevolent vandals who will misuse the opportunity. The QRator data suggests that 'radical trust' in visitors does indeed work: spamming and inappropriate commenting does not appear to have happened to a significant extent in the Grant Museum. The Grant Museum staff embraced the experimental and innovative nature of the QRator project and decided that they would experiment with post moderation. Carnall et al. (2012) states;

> Bravely, in order to allow visitors' comments to appear instantly (avoiding a feeling that their comment had disappeared or was being vetted), and also avoiding constant monitoring by time-poor staff unable to react in real time, excluding the use of an expletives filter, all comments would be moderated by Museum staff only after they went live on the iPads. This very much displays the experimental nature of the whole project.

> Not only were we unsure about the quantity of comments that would need moderating, Museum staff hadn't reached a consensus on what kind of thoughts from visitors were acceptable. As a baseline procedure for the first round of questions it was decided that profanity and nonsense (e.g. "asdfghjkl") would be moderated out but the QRator team was not explicit about what would and wouldn't be moderated otherwise instead the first round of questions were used as a test case to inform how moderation worked in the future (Carnall et al. 2012, p.7).

When comparing the individual QRator questions, it can be seen that certain questions gained more visitor contributions than others (Fig. **Error! Reference source not found.**5).   Better the Devil received almost double that of Captive or Conserve. Both asked provocative questions encouraging

visitors to think and contribute, yet one received a significantly higher proportion of visitor contributions.
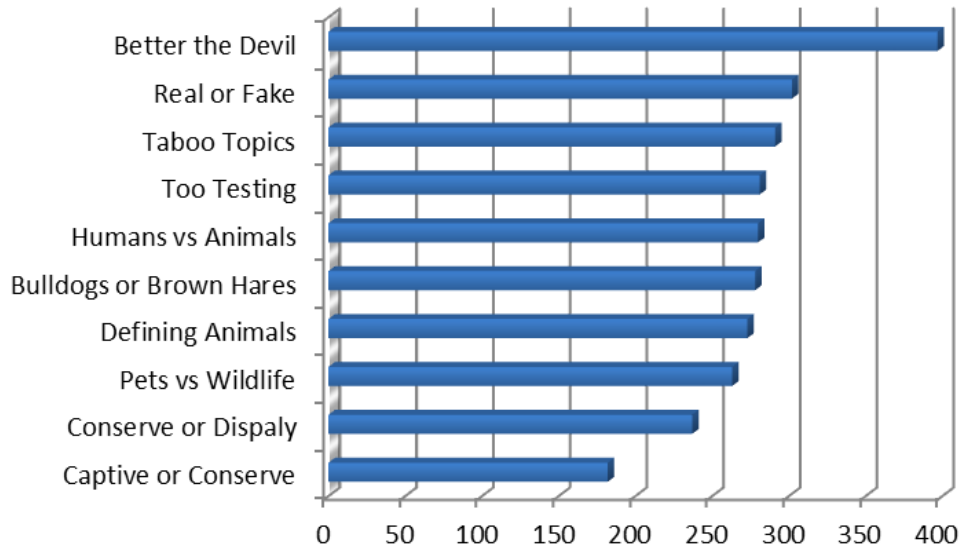

Fig. 5: Total number of visitor contributions for each QRator question

When further focusing on the individual QRator questions it is possible to see that some QRator question prompts produce higher levels of on topic comments then others (Fig. 6). The Real or Fake QRator question received the most contributions by visitors which focused on the topic raised by the museum (170 comments); followed by Pet vs. Wildlife (154 comments) and Humans vs. Animals (146 comments). This is likely to be because the QRator questions posed were more direct, easier to directly associate with visitors' previous experience and own perspectives, provoking a higher frequency of posts. In comparison with Bulldogs and Brown Hares which asks 'What makes an animal British' received a lower number of on topic posts (87 comments) but a high number of comments 'about the museum' (136 comments). The lower number of on topic responses may be due to the question prompting visitors to consider reasonably difficult questions about how long it takes for a species become 'native' and if it matters if a species was transported here by humans or naturally colonised? These are quite challenging questions to answer without prior knowledge of the issue and may have discouraged some visitors from responding. However, the Grant Museum

felt it was important to ask visitors to contribute to conversations on these issues in order to open up to a wider public debates that are often restricted to specialist disciplines (Carnall et al. 2013, p.66).
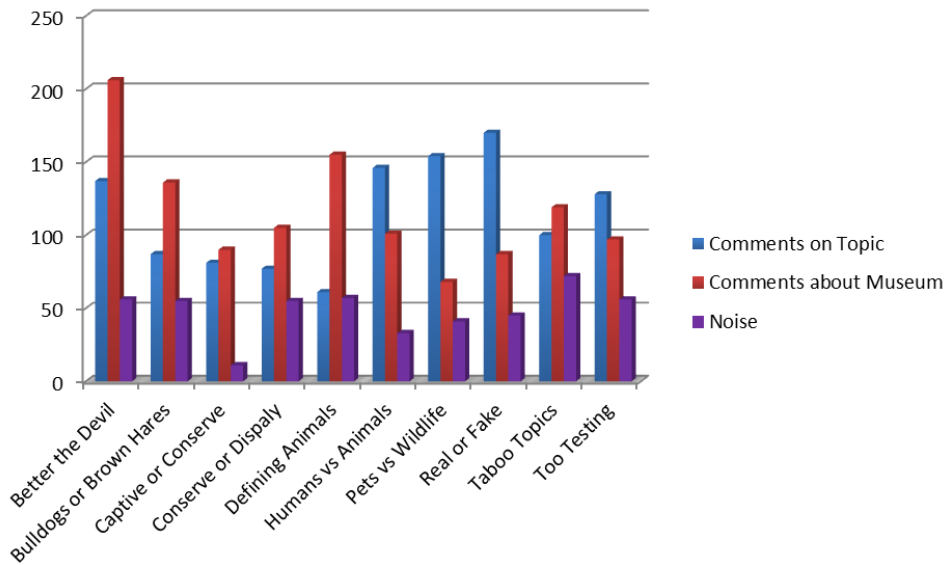

Fig. 6: Category breakdowns from each of the ten QRator iPads.

In order to gain further insight into the impact of QRator on the visitor experience, it was felt necessary to re-code the visitor contributions by capitalising on Grounded Theory's cyclic nature (Strauss and Corbin 1998), we were able to progress the analysis of the QRator data. Through the cyclical process of re-reading the data, it was possible to refine the analysis and split one of the basic categories; 'about the museum', into further sub categories. This re-coding provided more detailed understanding of how visitors were interacting with the QRator digital technology. The contributions of the 'about the museum' category underwent code splitting; a number of sub categories were produced: opinion; question; related to a specific object; related to a group of objects; overall experience; request; and conversation. The majority of responses (50%) fell into the category of opinion (Figure 7). The visitor contributions in this category, predominately entailed one word statements like 'awesome', 'cool' and 'amazing' (Table2). Though there are a range of negative comments including 'gross' and 'boring'. Although it might be easy to dismiss this style of

comment as irreverent and facile, it nevertheless is a significant form of visitor contribution. It is questionable whether one word answers can provide an insight into the impact of digital technology on visitor experience. Nevertheless, many of the one word answers contain strong sentiment adjectives (Table 2) making it possible to obtain information of what visitors what visitors liked or disliked and the high percentage of opinion category visitor contributions does suggest that the opportunity provided by QRator for visitors to give their opinion, has had a positive impact.

Frequencies	Count	Frequencies	Count
cool	77	good	23
museum	64	great	21
place	64	interesting	20
love	60	things	14
like	44	stuff	13
amazing	40	best	12
animals	40	awsome	11
wow	28	brilliant	11
really	26	weird	10
awesome	24	Fun	8

Table 2: Table highlighting the most popular words in the category Opinion. Words and phrases are spelt and capitalised exactly as they appeared in the QRator system.

Specific Object responses (18%) were interesting, as visitors chose to highlight key specimens within the museum. This category refers to specimens that visitors have seen and want to reference. For

example, the Jar of Moles specimen was cited the most in visitor responses with a count of 31 mentions. Visitors point each other to objects and specimens without the interference of museum staff.

> One major thing that we didn't anticipate is that people are also using them as a kind of digital visitors book. As well as getting involved in the conversations, people are letting us know their thoughts on the Museum in general and what they like or dislike about many of our specimens. The jar of moles gets a lot of mentions. This has become a great way for visitors to point things out to each other without us telling them what we think they should see (Ashby 2013 pers. comm. 25th November).

Visitors are using the QRator application in a very democratic way to state what they have learnt, or remark about a specimen which they think should be highlighted. Visitors highlighting key specimens through the QRator application has "become a great way for visitors to point things out to each other without us telling them what we think they should see." (Ashby 2012 pers. comm. 2nd March). This suggests that QRator has opened up new opportunities at the Grant Museum for visitor centric wayfinding, enabling visitors to suggest new ways to navigate other visitors to the species and exhibits they wish to highlight.
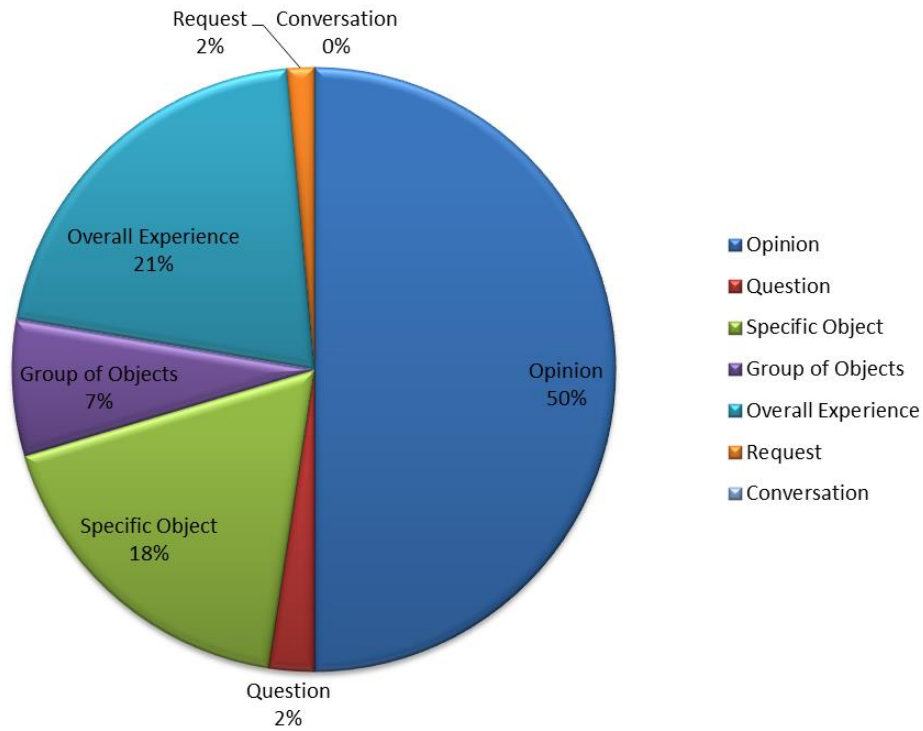
Fig. 7: Visitor contributions for 'about the museum'; re-coded into further subcategories

Analysing the frequency of comments according to date and time (Table3), comparing comment rate between the visitor contributions and total number of visitors to the Grant Museum also produces some interesting results.

Current Question	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Better the Devil	80	93	69	60	67	28
Bulldogs or Brown hares	43	50	49	50	58	29
Captive or Conserve	28	35	43	33	34	10

Conserve or Display	38	39	55	34	40	32
Defining Animals	43	51	53	59	45	23
Humans vs Animals	43	52	51	48	53	34
Pets vs Wildlife	32	53	62	28	51	38
Real or Fake	52	50	56	48	64	31
Taboo Topics	51	58	48	47	71	17
Too Testing	40	65	51	52	51	23
Total number	450	546	537	459	534	265

Table 3: Daily frequency of QRator Visitor Contributions

Firstly it is possible to see that Tuesdays, Wednesdays and Fridays are more popular for visitors engaging with the QRator iPads, Saturday is significantly lower. However this is likely to be due to limited Saturday opening at the Grant Museum[13].

In terms of actual visitor contribution practice, Fig. 8, displays the total visitor contribution levels, which can be compared to the on topic contribution category (Fig. 9). From this it can be seen that there are a series of spikes in visitor contribution activity. The 19th March 2011 received the highest number of contributions with 144 incidences. This coincides with the opening week of the Grant Museum and a Saturday celebratory event, so it is not particularly surprising that there was a high number of contributions. This high peak is followed by the 12th April, 26th October and 23rd May with

---

[13] The Grant Museum is open to the public Monday - Saturday 1-5pm. The museum is also open for group and research visits on weekday mornings 10am - 1pm. Saturday opening. started on the 6th October 2012. At the time of data collection (March –November 2011), the Grant Museum was only open to the public Monday-Friday, only opening on Saturdays for special events.

103, 88 and 80 visitor contributions. The regular troughs of 0 contributions coincide with weekends and closure days when the Grant Museum is closed to the public. However, there is an unexplained occurrence of 0 contributions between 15th June and 24th June 2011, the museum was not closed during this period nor were there any noted disturbances with the QRator system. When looking at the incidence of on topic visitor contributions there is a high peak on the 19th March 2011 with 72 contributions. This high peak indicates that half of the visitor responses left on that date were "on topic" and focused on the QRator question asked by the museum. There are also relatively high spikes on 15th April (35 contributions) and the 17th March and 12th April with 30 "on topic" contributions each.
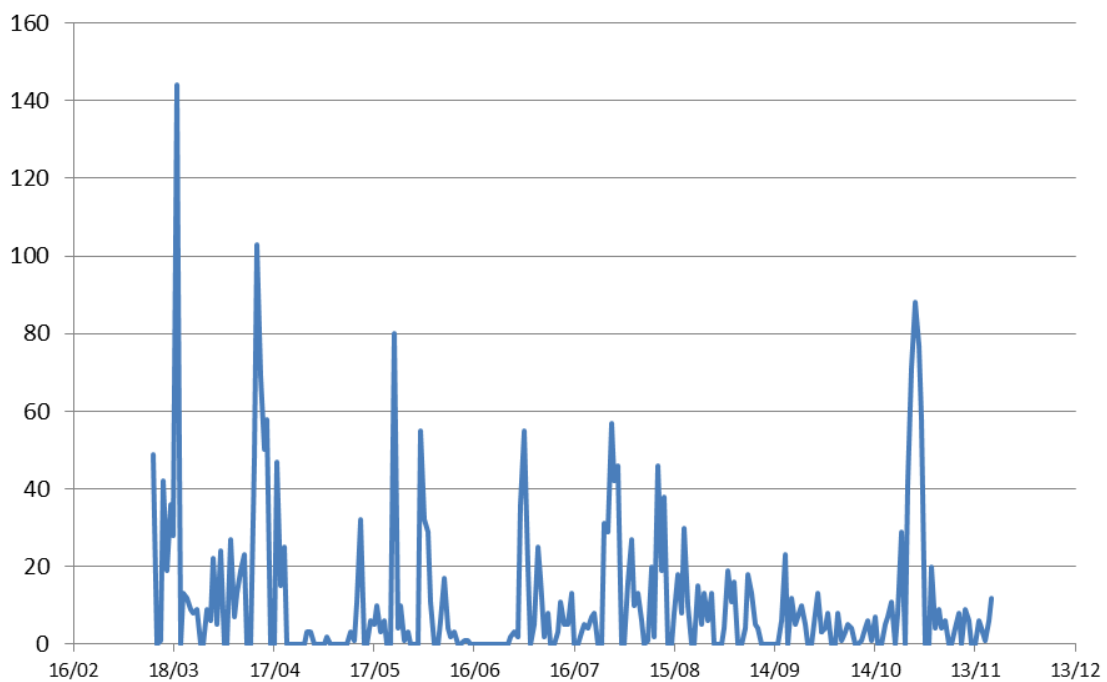
Fig. 8: Total number of visitor contributions to QRator by date
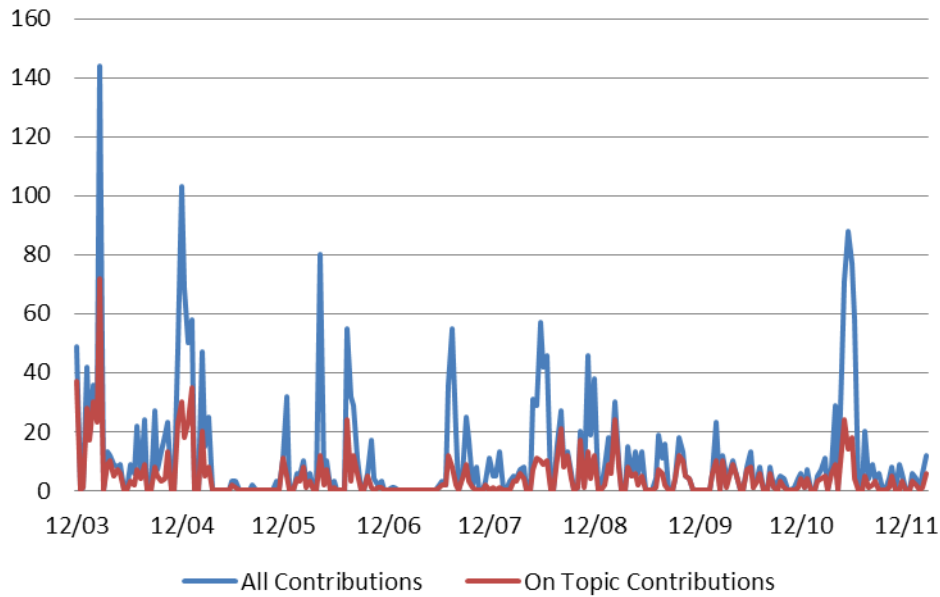
Fig. 9: Comparative analysis of 'on topic' contributions against the total number of contributions

If a focus is made upon the 'on topic' contributions by each iPad QRator question a range of spikes can be seen (Fig. 10). All the QRator questions display a spike on the 19th March, with Real or Fake having the highest spike of 12 contributions. Pets and wildlife displays another 12 contribution spike on the 31st May 2011.
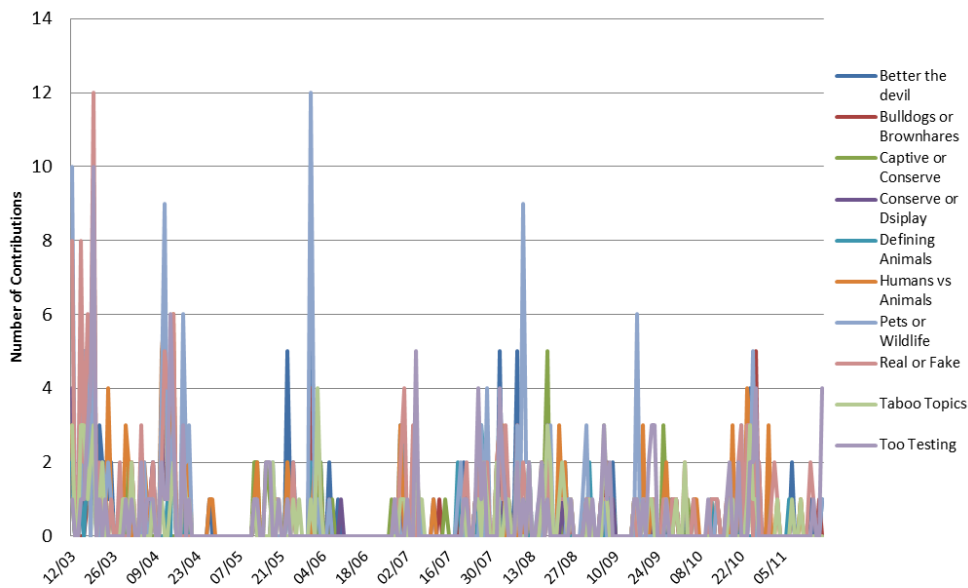

Fig. 10: Comparative analysis of 'on topic' contributions by QRator question

When comparing the total number of visitor contributions against total number of visitors to the Grant Museum it is possible to see that, assuming visitors make no more than one contribution per visit, 29% of visitors make a contribution to QRator. This assumption may not be accurate, as demonstrated by data from April, where the number of visitor contributions were slightly higher than the number of visitors. After an initial surge in visitor numbers after the museum opening in March, there was a decline in overall visitors in April. Anecdotal evidence does suggest, however, that the visitor figures may not be accurate in April, due to event visitors being quantified separately to standard visitor figures (Ashby 2012 pers. comm. 16th March 2012). The general trend, however is of increasing visitor numbers over the peak summer season, with a maximum of 1436 visitors seen during August (Fig. 21). In comparison, visitor contributions to QRator saw a small rise shortly after opening, so that there were more contributions than visitors in April. Throughout the remainder of the 9 month study period, visitor contributions remained steady, if fluctuating slightly. This suggests that 1 in 3.35 visitors to the museum choose to leave a contribution on one of the QRator iPads (Fig. 32). It would be expected that during the rise in visitor numbers during the peak season of June to September that the number of visitor contributions would also increase. This is not the case. This suggests that less people contribute proportionately in busy periods, and the reasons for this could be due to the museum environment not being conducive to contributing in busy spells, in comparison when there is more time and space to contribute during quieter periods. This could explain the reasoning why there were more visitor contributions in April, as there were less visitors in the museum.
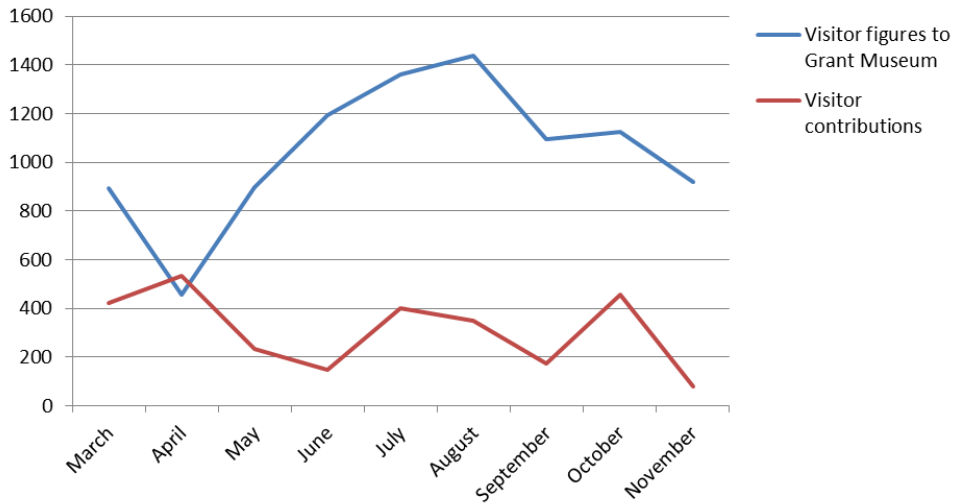
Fig. 21: Comparisons between total number of visitors to the Grant Museum, and total number of visitor contributions on QRator
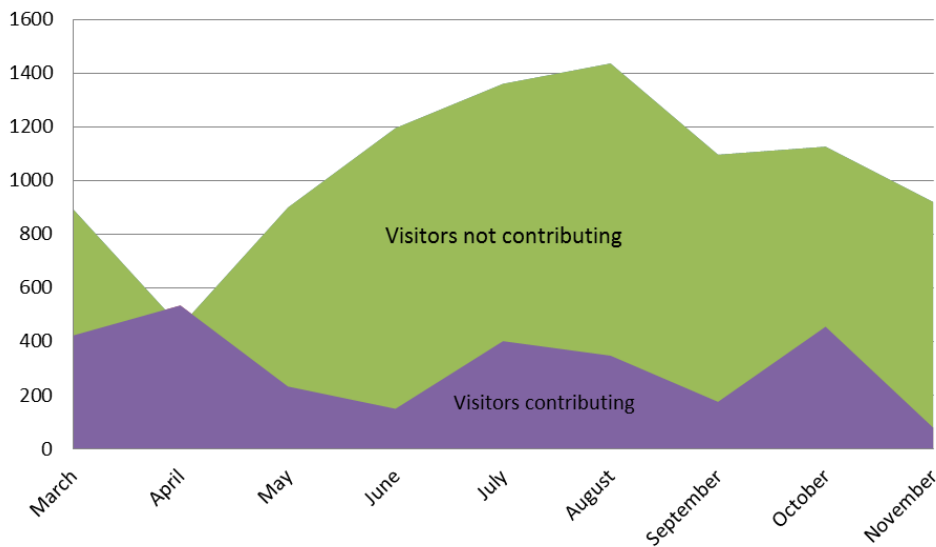

Fig. 32: Number of visitors contributing to not contributing

Text analysis tools were also used to interrogate the corpus of visitor contributions. The analysis of visitor comments is similar to that of other kinds of texts and qualitative research data and is therefore, in principle, open to many of the analytical techniques that are employed for textual analysis in other contexts (Macdonald 2005). It was assumed that frequent terms from QRator would reflect the topics and themes being discussed in the physical museum space. The QRator data

was run through a commonly used text analysis tool Voyant[14], to highlight the commonly used words in the visitor contribution, and to enable a Sentiment Analysis using SentiStrength[15] to take place. The most frequent words in the corpus seem to highlight positive visitor contributions as well as the key topics discussed the natural history specimens, the museum, and the action QRator is encouraging visitors to undertake: animals (288), like (218), museum (186), think (159), love (148). The length of comment may also be used as an indicator of engagement, if we assume that those who are interested in an issue or topic may wish to write at greater length. Indeed the average length of comment increased significantly between categories. The noise category had an average of 4.1 words, comments on the museum had 7.4 words and visitor contributions on topic had an average of 15.4 words. This is pleasing, since it suggests that visitors were inspired by the questions to engage with topics in a relatively complex fashion.   Additionally, when compared to the SentiStrength results, which classifies for positive and negative sentiment on a scale of 1 (no sentiment) to 5 (very strong positive/negative sentiment), this highlights that the comments on the museum were in average more positive in sentiment (2.04 positive) whereas the comments on topic had an equal positive to negative response (1.52 positive; 1.55 negative). This, in turn, Suggests more engaged texts often contain a mix of positive and negative sentiment, in contrast to less engagement which is more likely to produce a single sentiment result.

CONCLUSION

Digital technologies are becoming more embedded, ubiquitous and networked, with enhanced capabilities for rich social interactions, context awareness and connectivity. This has led to unprecedented changes in the provision of digital museum resources, which are beginning to transform the experience of visiting museums. The QRator project represents a shift in how cultural organisations act as trusted and authoritarian institutions; communicate knowledge to the

---

[14] Voyant Tools is a web-based reading and analysis environment for digital texts. http://voyeurtools.org
[15] http://sentistrength.wlv.ac.uk

community; and integrate their role as keepers of cultural content with their responsibility to facilitate access to content. It also suggests that users are willing to take part in a dialogue, and express their views about their visit and individual object via digital technologies. It further suggests that in most cases they can be trusted to do so in a thoughtful, serious fashion. The challenges that digital technology and participatory media bring to museums demonstrate a change from a one to many transmission to a many to many interaction, in which museums use their own voice and authority to encourage participatory communication and content creation with visitors. The growing emphasis on the interactional and informal nature of learning in museums provides the perfect opportunity to showcase digital interactive technologies as important resources for engaging visitors in exhibits and more generally in museums as a whole (Thomas and Mintz 1998; Marty and Burton Jones 2007; Heath and vom Lehm 2010). Given the importance of public engagement within the UK, developing an evidence base for best practice in digital technology, cultural heritage and public engagement is imperative. Digital technologies are opening up new opportunities for scholarly engagement with non-academic audiences, and we believe that Digital Humanities as a discipline can learn from Museums and cultural heritage about the importance of incorporating public engagement activities into research. Digital engagement projects embracing collaboration between academics, cultural heritage institutions and the public have the potential to significantly move forward the process of embedding engagement in academia. Not only could they challenge Digital Humanities academics to consider engaging the public more fully, but they could also provide the incentive to increase the quantity and quality of public engagement research and embed it into core academic practice.

REFERENCES

- Alelis, G., Bobrowicz, A., & Ang, C. S. 2013. Exhibiting Emotion: Capturing Visitors' Emotional Responses to Museum Artefacts. In *International Conference of Design, User Experience, and Usability* (pp. 429-438). Springer Berlin Heidelberg.

- Alexander, J., Barton, J. and Goeser, C. 2013. Transforming the Art Museum Experience: Gallery One. In N. Proctor & R. Cherry, eds. Museums and the Web 2013. Silver: Museums and the Web. Available at: http://mw2013.museumsandtheweb.com/paper/transforming-the-art-museum-experience-gallery-one-2/

- Black, G. 2005. The Engaging museum: Developing museums for visitor involvement. New York: Routledge,

- Burkett, E. 2005. Using handheld computers to stimulate critical studies in A-Level art, Becta.
  http://www.evaluation.icttestbed.org.uk/learning/research/secondary/interest/collaboration (accessed 20th January 2011)

- Cameron,F. 2003. Digital Futures I: Museum Collections, Digital Technologies, and the Cultural Construction of Knowledge. Curator, 46, no 3: 325-40

- Falk, J. H. et al. 2002. A multi-institutional study of exhibition interactives in science centers and museums. Unpublished evaluation report. Annapolis, MD: Institute for Learning Innovation, (2002)

- Falk, J.H., and Dierking, L., 2000. Learning from Museums. Visitor Experiences and the Making of Meaning. Walnut Creek, Lanham, New York and Oxford, Alta Mira Press

- Fichter, D. 2006. Web 2.0, library 2.0 and radical trust: A first take. April 2. Accessed 27th October 2011 at http://library2.usask.ca/~fichter/blog_on_the_side/2006/04/web-2.html.

- Filippini-Fantoni, S., McDaid. S., and Cock, M. 2011. "Mobile devices for orientation and way finding: the case of the British Museum multimedia guide" (2011). In J. Trant and D. Bearman (eds). Museums and the Web 2011: Proceedings. Toronto: Archives & Museum Informatics. Published March 31, 2011. http://conference.archimuse.com/mw2011/papers/mobile_devices_for_wayfinding

- Fisher, M., and Twiss-Garrity, B.A. 2007. "Remixing Exhibits: Constructing Participatory Narratives With On-Line Tools To Augment Museum Experiences". In Trant, J., Bearman, D. (eds). Museums and the Web 2007: Proceedings. Toronto: Archives & Museum Informatics. Available from: http://www.archimuse.com/mw2007/papers/fisher/fisher.html (accessed on 19th October 2010)

- Gay, G., and Spinazze, A. 2002. Handscape: exploring potential use scenarios for mobile computing in museums, Cultivate Interactive,8, (2002)

- Giles, J. 2010. Barcodes help objects tell their stories. New Scientist, 17th April, 2010

- Gray, S. et al., 2012. Enhancing Museum Narratives with the QRator Project: a Tasmanian devil, a Platypus and a Dead Man in a Box. In Museums and the Web 2012.

- Hall, P. 2010. Community engagement in South African higher education, Kogisano (6) (2010), 3–53 South African Council on Higher Education.

- Heath, C. & Lehn., D. vom, 2010. Interactivity and Collaboration: new forms of participation in museums, galleries and science centres. In R. Parry, ed. Museums in a Digital Age. Abingdon: Routledge, pp. 266–280.

- Hsi, S. 2003. "The Electronic Guidebook: A Study of User Experiences Mediated by Nomadic Web Content in a Museum Setting." Journal of Computer-Assisted Learning, vol. 19, no 3 (September): 308–319.

- Johnson, L., Adams, S. & Witchey, H., 2011. The NMC Horizon Report: 2011 Museum Edition, Austin, Texas.

- Katifori, A., Karvounis, M., Kourtis, V., Kyriakidi, M., Roussou, M., Tsangaris, M., Vayanou, M., Ioannidis, Y., Balet, O., Prados, T., Keil, J., Engelke, T., & Pujol, L. 2014. CHESS: Personalized Storytelling Experiences in Museums. In Mitchell, A., (Ed.), The Seventh International Conference on Interactive Digital Storytelling (ICIDS 2014), LNCS 8832 (pp. 232–235). Springer International Publishing Switzerland.

- Kelly, L. 2006. Museums as sources of information and learning: The decision-making process. Open Museum Journal 8. Accessed at http://archive.amol.org.au/omj/volume8/volume8_index.asp.

- Kidd, J. 2014. Museums in the New Mediascape: Transmedia, Participation, Ethics. Ashgate, Surrey, Burlington

- Lowdermilk, T. 2013. User-Centered Design: A Developer's Guide to Building User-Friendly Applications. O'Reilly Media, Inc.

- Lynch B. T. and S. Alberti. 2010., Legacies of prejudice: racism, co-production and radical trust in the museum. Museum Management and Curatorship. Vol. 25, 1:13-35 http://www.artsmanagement.net/downloads/Lynch-Alberti.pdf

- Mannion, S., Sabiescu, A., and Robinson, W. 2016. Innovate or stagnate: Disrupting the conventional audio guide. MW2016: Museums and the Web 2016. Published April 2, 2016. http://mw2016.museumsandtheweb.com/paper/innovate-or-stagnate-disrupting-the-conventional-audio-guide/

- Marty, P., and Burton Jones, K. 2007. Museum Informatics: People, Information, and Technology in Museums. Routledge, New York.

- Naismith, L., and Smith, M. P. 2009. Using Mobile Technologies for Multimedia Tours in a Traditional Museum Setting. In, Ally. M.(ed). 2009. Mobile Learning: Transforming the Delivery of Education and Training. Au Press, 247-264

- Naismith, L., Lonsdale, P., Vavoula, G., and Sharples, M. 2005. Literature review in mobile technologies and learning. A report for NESTA futurelab.

- Naismith, L., Sharples, M., and Ting, J., 2005. Evaluation of CAERUS: a Context Aware Mobile Guide. In van der Merwe, H. & Brown, T. (eds.) Proceedings of mLearn 2005 – Mobile technology: The future of learning in your hands, Cape Town, South Africa, 2005: 112-115.

- NCCPE 2015 What is Public Engagement (www.publicengagement.ac.uk/explore-it/what-public-engagement)NCCPE (National Co-ordinating Centre for Public Engagement

- Nielsen, J. 1993. Usability Engineering. San Francisco: Morgan Kaufmann.

- Nielsen, J. 2001. Ten Usability Heuristics, www.useit.com/papers/heuristic

- Norman, D. A, and Draper, S.W. 1986. User-Centered System Design: New Perspectives on HumanComputer Interaction. Erlbaum, Hillsdale, NJ, 1986.

- Pang, B. and Lee, L. 2008. Opinion Mining and Sentiment Analysis D. D. Schmorrow & L. M. Reeves, eds. Foundations and Trends® in Information Retrieval, 2(2), p.1-135. Available at: http://www.nowpublishers.com/product.aspx?product=INR&doi=1500000001.

- Parry, R. 2010. Museums in a Digital Age R. Parry, ed., Oxford: Routledge.

- Pérez-Sanagustín, M., Parra, D., Verdugo, R., García-Galleguillos, G., & Nussbaum, M. 2016. Using QR codes to increase user engagement in museum-like spaces. Computers in Human Behavior, 60, 73-85.

- Pierroux, P., and Ludvigsen, S. 2013. Communication interrupted: Textual practices and digital interactives in art museums. In K. Schrøder, & K. Drotner (Eds.), The connected museum: Social media and museum communication. (pp. 153–176) London: Routledge.

- Prescott, A. 2012. Consumers, creators or commentators? Problems of audience and mission in the digital humanities. Arts and Humanities in Higher Education, 11(1-2), 61-75.

- Proctor, N., Burton, J., and Tellis, C. 2003. "The State of the Art in Museums Handhelds in 2003". In Proceedings of Museums and the Web 2003. Toronto: Archives & Museums Informatics,. http://www.archimuse.com/mw2003/papers/proctor/proctor.html (access on 20th January 2011)

- Rodley, E. 2013. What can museums learn about immersive theater? Thinking about museums. Available at: http://exhibitdev.wordpress.com/2013/03/30/what-can-museums-learn-about-immersive-theater/

- Ross, C. 2014. Radical Trust Works: An Investigation of Digital Visitor Generated Content and Visitor Engagement in Museum Spaces. Doctoral thesis, UCL (University College London).

- Røtne, O., and Kaptelinin, V. (2013). Design Choices and Museum Experience: A Design-Based Study of a Mobile Museum App. In *Human Computer Interaction* (pp. 9-13). Springer International Publishing.

- Russo, A., Watkins, J., Kelly, L., & Chan, S. 2008. Participatory communication with social media. Curator, 51 (1), 21–31.

- Schultz, M.K. 2013. A case study on the appropriateness of using quick response (QR) codes in libraries and museums. Library & Information Science Research, 35 (3) (2013), pp. 207–215

- Silverman, L.H., 1995. Visitor Meaning-Making in Museums for a New Age. Curator, 38(3), pp.161–170.

- Simon, N. 2010. Chapter 6: Contributing to Museums. In, The Participatory Museum. Santa Cruz: Museum 2.0, 2010.

- Spadaccini, J., and S. Chan. 2007. Radical trust: The state of the museum blogosphere. In Museums and the Web 2007: Proceedings ed. J. Trant and D. Bearman. Toronto: Archives and Museum Informatics. www.archimuse.com/mw2007/papers/spadaccini.

- Speed, C., and Kanchana Manohar, A. 2010. Storytelling within an Internet of Things. In R. Aylett et al., eds. Interactive Storytelling Lecture Notes in Computer Science Volume 6432. Heidelberg: Springer, pp. 295–296.

- Strauss, A., & Corbin, J. 1998. Basics of qualitative research: Techniques and procedures for developing grounded theory (2nd ed.). Thousand Oaks, CA: Sage.

- Tallon, L., and Walker, K. 2008. Digital Technologies and the Museum Experience: Handheld Guides and Other Media 1st ed., Lanham, MD: Altamira Press.

- Terras, M., Warwick, C., and Ross, C. 2011. "Building Useful Virtual Research Environments: The Need for Used-led Design." In P. Dale, J. Bears, and M. Holland (eds). University Libraries and Digital Learning Environments. Ashgate, Surrey, Burlington: 151-167

- Thelwall, M, Buckley, K. and Paltoglou, G., 2012. Sentiment strength detection for the social Web. Journal of the American Society for Information Science and Technology, 63(1), pp.163–173.

- Thelwall, M., Buckley, K., and Paltoglou, G. 2011. Sentiment Strength Detection for the Social Web. Journal of the American Society for Information Science and Technology, 63(1), pp.163–173. Available at: http://www.scit.wlv.ac.uk/~cm1993/papers/sentistrength2_preprint.doc.

- Thomas, S. and A. Mintz, Eds. 1998. The Virtual and the Real: Media in the Museum. Washington, DC, American Association of Museums.

- Vredenburg, K., & Butler, M. B., 1996.Current Practice and Future Directions in User-Centered Design. Usability Professionals' Association Fifth Annual Conference, Copper Mountain, Colorado

- Walker, K. 2008. "Structuring Visitor Participation." in Digital Technologies and the Museum Experience: Handheld Guides and Other Media, edited by Loïc Tallon and Kevin Walker, AltaMira Press, August 2008