

The relationship between engagement and learning in school students' interactions with technology-driven multimodal exhibits in museums

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Abstract

This thesis reports a qualitative study of the use of multimodal technologies in museums— specifically, it examines the relationship between visitor engagement and learning, focusing on the use of multimodal technologies during school trips.

The study was conducted in the Natural History Museum and the Churchill Museum, both in London, with participants from several secondary schools. These sites were chosen due to their concern for the added value of learning and public engagement, including their education-orientated investments in technology, museum activities, and architecture. In the course of data collection, visits were made to six schools and both museum sites; the participants included 117 students, 18 teachers, three museum educators, and eight museum curators and media designers.

The study used a combination of video data analysis, stimulated recall interviews, document analysis, and engaging students in talk and reflection about their visit both at the museum and afterwards. The qualitative approach and multimodal analysis identify how the students' social interactions help them construct learning through decontextualised bodily movements, which trigger contextualised discussion.

The study demonstrates how multimodal analysis can be used in research to capture a wide scope of information, while maintaining a micro-level of analysis and understanding—here, capturing the detail of students' interactions and perceptions. The findings suggest that the learning experience in museums is produced through multiple layers of interaction and through the exchange of physical and psychological behaviour among people, resources, and space. Here, the multimodal technologies with which the students engaged essentially acted as initial platforms for sensory stimuli and social interaction, supporting their peer communication and motivating them to further explore both the given topic and their own understanding of their learning methods. It was the students' further conversation, observation, and participation, however, that created a more meaningful and entertaining learning experience in the museums.

Chapter 1: Introduction

1.1 Overview of the thesis

This study seeks to explore how students engage and learn with technologies in museums. Specifically, it examines how students who visit museums on field trips relate to authentic physical exhibits, museum activities, and museum educators in tandem with technology-driven multimodal exhibits.

The word ‘multimodal’, denoting multiple communicational forms, is used to encompass the complexity of a museum’s use of technology in relation to its function, structure, pedagogy, and practice. This refers to digital technologies incorporating several media elements, such as sound, graphics, text, and video, with emphasis on the sensory input. The museum technologies considered herein are categorically multimodal, combining features that include the multiple functions of the devices themselves as well as the very architecture of the space that houses them.

Central to this thesis are the fundamental questions of whether students engage in learning in museums with such technology, and how this takes place. Answering such questions has the potential to help schools, institutions, and the technology design industry to understand how technology should, or could, be used to enhance the overall learning experience in museums. Instead of focusing solely on ‘learning impact’ and the novelty of technological devices, museum designers and educators could use this study

to better understand how to provide a meaningful learning context and visiting experience through providing student visitors with engaging resources.

1.2 Learning in museums with new technologies

Educational role of museums

The educational role of museums did not become prominent until the 1970s and 1980s, but it has developed substantially over the last three decades (Hooper-Greenhill, 1999). Museums have worked to become more accessible to visitors—to become more than mere repositories of artefacts. Thus, museums increasingly try to provide innovative ways for the public to engage interactively with the exhibits. In some museums, some of the artefacts are even exposed to allow visitors to have more hands-on experiences (Milekic, 2000; Marty and Jones, 2009). Museums have adopted the notion of serving as 'educational references', with the goal of providing stimulating presentations and interpretations for visitors, motivating them, helping them develop an interest in the subject matter, and inspiring their lifelong learning.

The gradual shift to focusing on visitors' learning experiences has led many social scientists to explore teaching and learning methods in museums (Hooper-Greenhill, 1994; Schwartz, 2008; Atkins, Goudy and Dunbar, 2008). To this end, a numbers of studies have proposed various learning theories and models as potential guidance for both the institutes and schools in contextualising and supporting ways of enhancing this potential for learning in museums (Falk and Dierking, 1992; 2000; Falk and Storksdieck, 2009).

Researchers such as Falk and Balling (1979) reinforce the value of school outings, which, they argue, have the potential to improve students' attitudes and learning. In some cases, studies have found that shared and group experiences provide an effective means to create engagement and participation with museum exhibits (Grinter *et al.*, 2002; Heath *et al.*, 2002; Meisner *et al.*, 2007)

Whilst there is a growing number of researchers using various methods, especially qualitative data, to observe visitor behaviour and to interview visitors about what they have learnt, a full understanding of the ways in which visitors' interactions and behaviours occur is still lacking. It is as yet unknown whether these processes are considered, from the visitors' perspective, as learning or merely as a momentary engagement. The concept of learning in museums thus eludes definition due to its informal and voluntary nature. This becomes even more complex when the behaviours studied accompany a school-group activity—with certain expectations for student-visitor learning arising from the schools and the museums themselves, visitors often lose the 'free choice' and 'leisure' aspects of visiting a museum.

To date, this question of what learning means in a museum is open. Meanwhile, many studies and museum policymakers continue to encourage the integration of school curriculum enhancement with museum activities (Hofstein and Rosenfeld, 1996; Eshach, 2006). One of the ways to support this engagement with learning is by adding innovative, state-of-the-art technologies, as many researchers consider digital technologies to now be

fully embedded within every aspect of our lives and cultures (Meisner *et al.*, 2007; Schwartz, 2008).

Embracing digital technologies in museums

Much of the pursuit of technology-driven exhibits has to do with studies, and with policymakers' perceptions, of the youngest generation, which has been variously referred to as 'digital natives' (Prenksy, 2001), the 'net generation' (Tapscott, 1999), 'millennials' (Howe and Strauss, 2000; 2003), and the 'digital generation' (Buckingham, 2007). These studies and policymakers reinforce widespread assumptions by stereotyping the present young generation as having much higher digital media literacy and competence in adopting the latest technologies than their elders (Prensky, 2001; Palfrey and Gasser, 2008). This has become a compelling driver for many museum professionals to embrace updateable technologies as a primary or supplementary tool in hopes of attracting the young public to engage and learn.

Investing in hands-on technology to support content delivery is not new to museums. It is now rare to see a museum without any form of hands-on technology. The plethora of technological tools that museums have adopted range from the simple handheld audio guide or information kiosk to animated robot simulations, sensory-based projections, and full mobile phone integration, but all of these tools are aimed at the same goal: to disseminate information and maximise visitors' participations and interactions.

Technology is believed to be an effective way to engage and stimulate visitors (Hein, 1998, p.2). In studies, the term 'multimodal technologies'

describes the sensory-rich and technology-driven exhibits that combine various media, such as video, audio, lighting, and architectural arrangements, with sensory-focused digital interfaces on top of traditional authentic objects and textual labels. The notion behind these multisensory designs is to emphasise physical action through the senses to trigger visitor interactions and interest in the content of the exhibits.

At some level, however, there is a danger that the drive to install the latest technological wonders can becomes museums' primary concern, relegating the question of whether the technology is improving visitor learning at all. Museums can begin to focus on the usability and accessibility of technologies instead of trying to understand the underlying issue of the many factors that influence visitor learning, from the very architecture of the space to the conversations amongst the visitors themselves. Crucially, some researchers argue that there is insufficient evidence of the effect on the learning experience generated solely by pushing buttons (vom Lehn and Heath, 2005; Meisner *et al.*, 2007; Marty and Jones, 2009). This suggests that previous studies, although valuable, were flawed—not only did they need to pay closer attention to the ways in which students engaged with the exhibits, but they also needed to study the forms of interactions generated by multimodal technologies. Looking further, it is also important to explore students' thoughts behind their interactions, and to recognise their perceived connexions and differences between engaging with museum exhibits versus learning as a whole. Thus, in order to understand these interactions, a detailed dataset and analysis is required to contextualise the complexity of

these relationships, visiting experiences, and the concepts of learning in museums.

In this thesis, the term ‘technology-driven multimodal exhibits’ (or ‘multimodal technologies’) is an umbrella term that comprises all of the chosen exhibits and media, including digital text, touch screen sensors, video, soundtracks, and more. Rather than focusing on one particular one piece of technology or interactive devices such as interactive tables, it embraces the surrounding environment and exhibits.

1.3 Research question

The underlying goal of this study is to examine how students develop relationships among a museum’s multimodal technologies, a museum activity, and authentic exhibits, while monitoring their social interactions with other visitors. This study is most specifically concerned with the way in which these forms of interactions influence students’ understanding of learning and their use of digital technologies to support their visiting experiences. This thesis is not intended to answer the question of whether technology should be used in museums, but rather to aid in understanding how and why visitors use it in relation to their learning. With those thoughts in mind, this investigation has analysed chosen devices in two museums and explores whether these devices can add educational value to students’ interactions with the rest of the exhibits. To facilitate such inquiry, the overarching question is:

What is the relationship between engagement and learning in students' interactions with technology-driven multimodal exhibits in museums?

In relation to the overarching questions, the operational questions are:

1) In what ways are school students engaged by technology-driven multimodal exhibits in museums?

2) To what extent and in what ways do these engagements result in experiences of learning?

The overarching research question recognises that whilst engagement and learning are two distinct concepts, they are closely related in the context of museums in that it is engagement with exhibits that is intended to engender learning. Engagement, in this context, refers to visitors' situated involvement and participation with the exhibits. Engagement provides connexions and opportunities for meaning making. It also serves to develop processes that incorporate values and drive behaviours. Learning, on the other hand, is a result that may derive from these engagement processes, depending on a visitor's perception and prior knowledge as well as his social and cultural background. Here, learning is not merely an acquisition of information or an expected outcome, but also the processes for making judgments or decisions. It signifies the relative importance of an evolving process, but could also be seen as an outcome. The overarching research question will be further discussed along with the two operational questions in Section 3.3.

1.4 Research context and design

The study will take as its contexts the Natural History Museum and the Churchill Museum, both in London.

Opened in 2009, the Cocoon at the Darwin Centre is a newly-developed site adjoining the world-renowned Natural History Museum. It consists of collections relating to botany, entomology, mineralogy, palaeontology, and zoology. The chosen multimodal technology here is a 'planning an expedition' table where visitors can choose the appropriate tools and materials for a virtual expedition. It includes two screens: one is an instructional screen, with a video simulation of a scientist asking questions and giving instructions, complete with sound and subtitles; the other screen, which responds to the sound screen, is a sensory projection from the top table, where visitors can digitally 'touch', 'move', 'type', and select among the given options. Additionally, the device also has a barcode-scanning function for the barcode card given to the students, which they can scan and record to collect factual information about their 'expedition', such as the function of a tool or basic information about a location.

The Churchill Museum is a branch of the Imperial War Museum in London, situated ten feet below the Cabinet War Rooms in a preserved historical site across from the Houses of Parliament in Westminster. The museum was opened in 2003 in dedication to Britain's former Prime Minister, Sir Winston Churchill. The chosen multimodal device is a 15-metre, multisensory, touch-sensitive table called the Lifeline Table. It provides access to voluminous digital folders for the events of every year, month, and

even day of Churchill's life in chronological order. By touching the interactive strip at the edge of the Lifeline Table, visitors can open files that uncover different contextual data, videos, photographs, and historical documents.

The rationale for choosing these two institutions was their recent financial investment in developing state-of-the art technologies to help represent their exhibits. Although the two museums cover different subject areas and provide different multimodal devices in terms of appearance and function, they had comparable design concepts and features, such as combining an interactive touch sensor, sound effects, video, digital text, and multiuser capability. In studying these two contexts, the data generated illustrates how various modes work across different subject fields and visitors. More fundamentally, the museums share a common goal: to provide physical sensory activity to motivate visitors to engage with the material and thereby experience being a researcher or a scientist.

1.5 Engaging with the researcher

Having worked with many museums and galleries, such as the National Gallery of Scotland, and having studied History of Art as an undergraduate, I find that places like museums and galleries provide particularly innovative, effective, and inspiring learning opportunities. Without heavy curriculum-driven pressure from school, learning in such places is unrestricted and entertaining. The culture of 'learning for a purpose' makes education less than enjoyable for many school students—and even adults—and so I argue that learning and fun should be combined. With the constant development of technology, many

museums have striven to do just that, using technology to entertain and educate simultaneously.

This study is funded by Taiwan's Ministry of Education, which seeks to find different ways to improve learning quality, motivation, and inspiration. The Ministry believes that learning, and enhancing the curriculum, can be achieved by alternative means. Many media and technology companies, such as the ones that collaborate with the two museums in this study, are keen to determine the 'how' and 'why' factors behind human and computer interfaces, especially when schoolchildren enter the picture. Moreover, the Learning Departments at both museums actively focus on educational principles in museum teaching, pedagogy, and technological investment through both practical and theoretical study. It is therefore my intention to deliver an in-depth, coherent, and succinct research overview with implications for both policy and practice. I am committed to exploring and refining fruitful methods of collecting and analysing evidence of learning in an environment that is highly challenging from a research perspective. By unfolding different dimensions of this study, I hope to find multiple ways of making learning inspiring, entertaining, and enjoyable.

1.6 Organisation of the thesis

The thesis is structured into eight chapters.

Chapter 2 opens with the essential theoretical and practical perspectives on the function of a museum, discusses how the pedagogical role was inserted, and explains the problem of measuring learning experience

from a voluntary learning environment. It continues by identifying current museum learning literature on how young people and new technologies, such as mobile learning and multimodal technologies, are positioned in this context.

Chapter 3 describes how this study sets out to investigate such interactions in detail, using a combination of methods. It also argues for the importance of using multimodal analysis in combination with the micro-level of scenario description to give the investigation an ethnographic quality.

Chapter 4 delineates the context, architectural layout, museum activity, and hands-on sensory device at the Natural History Museum and Churchill Museum. It offers a descriptive yet analytic justification for the pairing of these two museums based on the similarity of their approaches.

In Chapters 5 and 6, the findings of the study are presented and discussed. The ways in which students engage in learning in the museums through their interactions with the chosen multimodal technologies, authentic physical exhibits, textual displays, and museum educators are also explored. Part A in both Chapter 5 and 6 answers the first operational research question within the context of the Natural History Museum, while Part B answers the second operational question; the data for this section are derived from the semi-structured and stimulated recall interviews with the students one week and six to eight months after their visit, respectively.

In Chapter 7, the findings from Chapters 5 and 6 are integrated with reviews of existing literature and the chosen methodology. This chapter presents a final discussion of the overarching question, explaining the identified function of the role of multimodal technologies as sensory stimuli

and as initial attractions to motivate students' further exploration during their museum visit. This chapter also emphasises the importance of combining social and physical interactions in an unfamiliar environment, in addition to sharing individual and social learning experiences through meaning-making processes with digital resources. Another section discusses how much material the students retained six to eight months later.

Chapter 8 draws upon concerns, constraints, and further implications of the study, reflecting on the methodology, literature, and findings, discussing the importance of the result, and identifying future directions for research and practice.

Chapter 2: Literature Review

2.1 Introduction

In this literature review, the term ‘museum’ refers to institutions such as science centres, botanical gardens, zoos, and aquaria, as well as to institutions more traditionally associated with the term, such as the Natural History Museum. This chapter discusses the current research on the aspects of learning that museums provide through digital technologies, particularly multimodal technologies designed on top of the authentic exhibits and texts. It opens with the debate on the function and mission of museums and a review of young children’s use of technology, both inside and outside of the school setting. Next is a discussion and exploration of the different meaning-making processes encountered in many museum-based studies. This is followed by the rationale for installing new technologies in museums. The chapter continues by considering how different learning theories and pedagogies were adopted and developed as researchers attempted to understand the process of learning in this context. In this chapter, particular attention will be drawn to the lack of any in-depth exploration of the relationships between different areas of museums—for example, exhibits, museum educators, and different technologies. The present study, then, is unique because it tries to take a detailed narration and micro-level approach to the museum-based learning environment.

Although the literature review does not attempt to cover all aspects of the subject, this chapter presents a justification for the use of multimodal analysis in contextualising the concept of learning in museums. It also

introduces the terminology of multimodal technologies used in the study. This chapter operates as an aid to understanding the study's objective, helps refine the research questions, and provides a rationale for the methods chosen in this study.

2.2 Museums as places for learning

In general, museums are seen as a leisure space for voluntary learning, free from any school-like formal learning assessment, which, it is argued, gives them the capacity to inspire and motivate the public to understand their culture, history, science, and the society in which they live. Museums have a dual identity, serving as places of both entertainment and education, and they attempt to justify the co-existence of learning and fun through various media and platforms. Recently, some institutions have made greater investments in state-of-the-art and education-orientated technologies, with the intention of improving the public's engagement with the museum content and how they learn in museums. Two subjects that must be addressed, then, are what role technologies in museums play in relation to other exhibits, and how school students engage with these presentations and learn from their experiences from these museums.

Functions and missions

To explore the museum context in terms of new technology and learning, it is important to first recognise the original function of such places. Museum historian Jeffrey Abt (2011, p.115) suggests that the general association of the museum with organised and preserved collections and

study would have originated with Aristotle's travels with his student, Theophrastus, to the island of Lesbos in the mid-340s BCE. Their study involved a systematic and scholarly exploration process of 'collecting, studying and classifying botanical specimens' (*Ibid.,* p.116). Over more than two millennia, the concept of 'museum' has evolved from an institution for the academic classification of objects, to storage and exhibition spaces aiding scholars, to educational facilities for the public. Today, museums' focus has shifted from what they can deliver based on their collections, to what their audience would like to know from their collections.

Most of the current definitions of museums' functions revolve around museums' social, leisure, and educational aspects for the public, plus their research and storage elements for the academic community. For instance, the UK-based Museums Association defines museums as places that 'enable people to explore collections for inspiration, learning and enjoyment. They are institutions that collect, safeguard and make accessible artefacts and specimens, which they hold in trust for society' (Museums Association, 1998, n.p.). This definition is wide enough to describe a variety of missions, and indicates the complex and multifunctional position of museums.

One difficulty many museums face in carrying out their missions is the fact that their audience is not homogenous. Generally, a museum's audience is the public, which makes effective communication between the museum and all of its visitors challenging at times. This communication, however effective, has a notable sociocultural aspect; Leinhardt *et al.* (2002) emphasise the explicit and the tacit dialogue between museum professionals—collectors,

curators, designers, and educators—and visitors.

In short, museums are unique and complex social communities that face an important difficulty: communicating with and engaging visitors of all ages. The modern drive to educate visitors is another challenge that museums must surmount. In meeting this goal, they take on the role of interpreter and storyteller, sharing narratives through different representations of museum exhibits (Bitgood *et al.*, 1994, p.67).

The responsibilities of the museums are therefore varied and sometimes imprecise, depending on the choice of collections and the curatorial design in relation to the institutional objective and agenda. In other words, the quality of learning in a museum context depends upon the quality of the collection as well as on the individual visitor's preferences and interests—the result can be either effective learning or an uninspiring experience. It is subsequently, then, that there has been an increase in museum-based studies that seek to explore visitors' behaviour, attitudes, and expectations in order to help museum designers present a more multifaceted, entertaining, and approachable learning environment.

Making museums approachable is not a simple task, however. The majority of museums began as object-based institutions created for the purpose of conservation. They were traditionally considered to be 'cabinets' of curiosity, complete with the ubiquitous direction to 'look, but do not touch'. Thus, the conventional style of learning in museums tends to be self-motivated and less active, as objects do not 'speak' for themselves. In many cases, this decreases visitors' interest in the objects and motivation to pursue

further engagement. On top of this less vigorous tradition of display, museums face a great challenge in producing methods to maintain visitors' attention in extending the visiting experience toward learning, which will be discussed later in the chapter (Section 2.5). The difficulty, as philosopher John Dewey (1963, pp.13–14) points out, is that

> any experience is mis-educative that has the effect of arresting or distorting the growth of future experience …[E]ach experience may be lively, vivid, and 'interesting', and yet their disconnectedness may artificially generate dispersive, disintegrated, centrifugal habits…[T]hey are then taken, either by way of enjoyment or of discontent and revolt, just as they come.

Dewey argues that experience is not in itself educational, and in order to make it so, it must be tailored to the individual. He also notes the wide variety of experiences that a visitor may encounter and emotions he may feel, which affects the challenges of measuring how and when people learn during their visit, or whether they do so at all.

Combining formal, non-formal, and informal learning

As the educational function of museums has become more established, a growing number of studies and museum policymakers have advocated the integration of school learning materials and museum-based learning resources (Hofstein and Rosenfeld, 1996; Eshach, 2006; Atkins,

Goudy and Dunbar, 2008). Over the last three decades, the value of school outings to museums has been demonstrated in a number of studies; some of these suggest that students' attitudes and learning can be improved with appropriate preparation and collaboration between schools and museums (Falk and Balling, 1979; Ansbacher, 1998; Griffin, 2004). It is generally agreed upon by many museum-based researchers that 'learning' in museums is an informal process (Packer and Ballantyne, 2002). But when a school group visits a museum and participates in a museum activity, however, the boundaries among formal, non-formal, and informal learning blur as the three types of learning begin to meld into one experience. This section identifies the similarities and differences among the three to better understand museums' different approaches toward learning in relation to school children.

Learning in school is normally characterised as *formal learning* or *formal education*, and largely takes place through the medium of the school curriculum. It is compulsory and considered highly structured, and is regularly assessed. In contrast is *informal learning*—learning outside of school, which tends to be voluntary, spontaneous, and non-assessment oriented. This term has many connections with learning in museums, as many external supporting bodies, such as the Campaign for Learning in Museums and Galleries (CLMG) and the Museums, Libraries and Archives Council (MLA), strongly emphasise the importance of informal learning in museums. These groups stress that the core of a museum's mission is to support what people need, not merely as consumers, but also as producers. Therefore, they state that it is essential that museums foster visitors' engagement with the exhibits,

help them learn, and present enjoyable opportunities (Museums, Libraries and Archives report, 2009).

As Wellington and Ireson (2008, p.319) posit, however, formal learning is not always confined to school and informal learning is not always kept out. When museum visits are integrated with school curricula, informal and formal learning begin to work together. In light of this blending of learning types, some scholars, such as Eraut (2000), have argued for the adoption of a third term, *non-formal learning*. This term is meant to represent an approach to learning that is not supplied by an educational or training institution, but rather is structured with learning objectives to support the individual learner's needs (Eshach, 2006).

A school group's activity in a museum is still generally seen as an informal learning experience with learner-led, sociable, open-ended, and out-of-school characteristics (Falk and Dierking, 1992). Regardless, elements of formal and informal (and sometimes non-formal) learning have been seen during field trips to museums. When these learning types work in combination, each can help compensate for the drawbacks of the others. In some ways, this variety of styles makes the process of learning more enjoyable.

Some researchers even consider the museum experience 'creative learning', which can lead to intrinsic visitor motivation and engagement with the subject (Nakamura and Csikszentmihalyi, 2002). To this end, many museums try to integrate activities or sessions with the school curriculum, as there has been an increased demand for collaboration between schools and museums. Many studies have stressed the importance of connecting schools

and museums in order to support and accommodate different learning styles (Ansbacher, 1998; Cox-Petersen *et al.,* 2003; Sharples *et al.,* 2007). Some have found that visiting museums is one of the most effective ways to help students connect with the real-world context; hence, there is great support for school field trips to museums (Gardener, 1991; Watson and Houtz, 2003; Melber, 2008). To date, however, only a very small number of institutions have become aware of the importance of collaborating with schools, though some of these have set up long-term 'colleges' that have stronger relationships with schools in exploring feedback (Fitzgerald *et al.*, 2011).

On the other hand, some studies that have investigated school-based models argue that there is inevitably underlying tension in combining formal and informal learning in museums (Hawkey, 2004), such as working around school assessments, budgeting for time-consuming field trips, and managing the general school workload. Therefore, to bridge formal and informal learning (or even non-formal learning) without overloading students, many social scientists have examined the ways in which informal learning activities take place within museum-based learning environments with technology (Sharples *et al.,* 2007; Atkins, Goudy and Dunbar, 2008). The assistance of tools such as learning materials on a museum's website or a structured activity with a technologically-assisted guided tour may reduce the preparation time required for teachers and museum educators, making the field trip easier and more enjoyable for all parties.

Longer-term effect

In addition to the three approaches to learning described above, some

researchers have also studied students' lifelong learning experience, trying to measure from a psychological perspective how visitors' longer-term memory and education are affected by their museum trips (Stevenson, 1991). These studies can be problematic, however, as memory is organised around personal experience—it is not a simple insertion of information. These experiences may only be reasserted in later settings where the individual may connect information according to his own preferences (Schank and Abelson, 1977; Gardner, 1991; MacLachlan and Reid, 1994; Hooper-Greenhill, 2000). Therefore, without a pre- and post-test, or even with such an assessment, it is almost impossible to pinpoint to what extent and in what ways students' museum experiences are retained.

Nevertheless, scholars, schools, and museums are still interested in understanding how they can enhance students' interest in developing the capacity for lifelong learning. Some early studies even claim that remembering something from a museum visit can be considered as a product of learning (Falk and Dierking, 1997). A number of studies have focused on students' long-term memories, with some even trying to examine students' memories six months after their visit (Stevenson, 1991; Anderson, Storksdieck, and Spock, 2007). Many of these studies conclude that participants' recollections of their visit are tied to their activities during the visit, particularly their personal interest in the exhibit topic and whether they talked to someone else about the exhibits.

Still, there appears to be a lack of empirical research on the concept of long-term impact, and it remains difficult to accurately capture what students

have learnt from a short-term memory test. Most of these researchers tend to argue that basic descriptive and ethnographic research is needed to understand the 'natural history' of the museum visitor (Tulley and Lucas, 1991; Bitgood *et al.*, 1994; Evans and Sterry, 1999). Arguably, due to individuals' social and cultural background and interests, the longer-term impact or effect may still remain elusive. Although the longer-term impact is not the focus of this study, some elements of this will still be considered with the research questions to see whether students retain their visiting interactions or even what they have learnt over a longer period of time post-visit.

2.3 Young people and new technologies

Underlying issues in young people's use of technologies

The fundamental issue to consider prior to discussing education-orientated technologies that are used in the museum context is how adults—particularly those adults who design school curricula and museum exhibits—perceive the youngest generation's use of new technology. The past decade has seen numerous claims and debates about the radical changes in this stereotypically 'tech-savvy' generation. Today's children are considered to have higher media literacy and proficiency than their elders in adopting new technologies due to their exposure from birth to digital technology, and Tapscott (1998, p.40) even claims that, for this generation, 'using the new technology is as natural as breathing'. This group is also thought to be composed of dynamic and interactive learners who are competent at

multitasking, constantly connected, and accustomed to networking via various digital media (Prensky, 2001; Palfrey and Gasser, 2008). Labels for this generation include ‘digital natives’ (Prensky, 2001), ‘the Net Generation’ (Tapscott, 1998 and 1999), ‘the Millennials’ (Howe and Strauss, 2000 and 2003), and ‘the Digital Generation’ (Buckingham, 2007). These terms are widely used and have become common in mainstream discourse as well as in academic, especially educational, research (Partridge and Hallam, 2006; Downes, 2007; Toledo, 2007).

Technology is constantly developing in terms of usability, efficiency, and appearance: consider mobile devices, Internet search engines, social networking sites, and personal computers. This burst of technological innovation and adaptation has been frequently commented on; more importantly for this study, it has led researchers to recommend that educators and policymakers embrace new technologies and integrate them into formal educational methods (Collins and Halverson, 2009 and 2010). Moreover, there has been an increase in the physical ownership of new technologies, such as mobile phones and personal mobile devices like iPads and other tablet computers; many studies have demonstrated that a high proportion of students own mobile phones and laptops (Oliver and Goerke, 2007; Kenny *et al.*, 2009; Bennett and Maton, 2010; Digital Britain: The Final Report, 2010; Report, PEW Report, 2010). This, in turn, has influenced the development of the more recent buzzwords associated with learning and young people, such as *ubiquitous*, *social networks*, and *mobile*.

This flux of theoretical modification and the practical consumption of

technologies have led government and research bodies to seek out new ways of educating this 'future' generation (Facer and Sandford, 2010; Facer, 2011). This can be seen in one recent government document (Museum Libraries Archives Council, 2009; The Final Report, 2010) that outlines the UK's strategic policy and the vision that the country should prioritise digital development. All of this underpins widespread change in a number of social behaviours affected by the lifestyle and 'language' of this new generation.

One school of thought is that new approaches and practices in education are required in order to communicate with today's children. This notion has also become a strong driving force for many museum researchers, educators, and policymakers to follow and work closely with social scientists. This phenomenon was reported by the Museum, Libraries and Archives Council (2009, p.10), which stated, 'Digital technologies enhance access to collections, support research and learning, and stimulate and renew interest in original objects…Priority will be given to harnessing innovation, using the very best expertise, and avoiding waste and duplication.'

Proponents of the use of digital technology to enhance learning believe that it liberates and empowers children, suggesting that this generation's learning behaviours are interwoven with and dictated by the evolution of technology. To this end, numerous museums have pursued innovative ways of producing learning experiences for the new generation. Museums have embraced updateable technology, as 'today's students are no longer the people our educational system was designed to teach' (Prensky, 2001, p.1). As the argument goes, it is essential to deploy more interactive technologies,

as many researchers believe that information and communication technologies (ICT) are now fully embedded within every aspect of our lives and culture (Meisner, 2007; Schwartz, 2008).

Some researchers, however, have begun to oppose this argument, as they have found that the characterisations used to describe the younger generation are based merely on anecdotes and generalisations that lack empirical evidence (Bennett *et al.*, 2008; Helsper and Eynon, 2009; Bennett and Maton, 2010; Thornham and McFarlane, 2010). Bennett *et al.* (2008, p.7) suggest that the popularity of these terms and stereotypes is related to Cohen's social theory of 'moral panics', or scare-mongering by public discourse. Bennett and Maton (2010, p.321) further argue that there is 'a surfeit of "singularities"', one-off events that are viewed as revolutionary. As the studies on young people as highly adept technology users encompass a wide range of different contexts, one cannot apply a single case universally. Indeed, not every young person is growing up with digital technology—some studies have found that this 'natural behaviour and skill' depends on and is affected by other aspects, such as one's social, cultural, and parental background (Davies, 2011).

This debate continues. Even though many understand the problem of these terminologies, enthusiasts like Tapscott (1998) and many public figures still believe that technology liberates and empowers children, suggesting that digital natives' behaviour toward learning is interwoven with and dictated by the evolution of technology. Therefore, in the drive to embrace access to digital services and encounters, cultural institutions such as museums

become essential, as many researchers believe that they can bridge the 'digital divide' between those who have ready access to technology and those who do not (Economou, 2009). As this debate is not the focus of the present study, however, and as the nature of the 'digital natives' and the 'digital divide' is more complex than might be suggested here, this discussion serves only as a starting point in understanding the impetus for many public institutions in developing and investing in education-orientated technologies.

Adding education-orientated technologies to museums

Due to the aforementioned perceptions of young people's behaviour and use of new technologies, numerous museums have adopted education-orientated technologies as a primary or supplementary tool to increase public engagement and learning. Museums such as the Natural History Museum, the Science Museum, and the British Museum frequently collaborate with academic institutions in evaluating and assessing the quality of their learning activities and technological devices. Many museums aspire to maximise visitors' participation by implementing interactive attractions, such as hands-on features, which are believed to be an effective way of empowering visitors and stimulating a 'minds-on' mentality (Hein, 1998, p.2). It is difficult today to find a museum without any form of hands-on technology.

Hands-on interaction is believed to break down the traditional mentality of the 'do not touch sign' between visitors and exhibits, and to ease access to information (Falk and Dierking, 2000; Marty and Jones, 2009). Moreover, many studies find that children develop their understanding of the world from their sensory experiences, which can particularly be seen through science

teaching (Driver, 1994). In such cases, the physical action serves as a motive for engaging with the exhibits, as sometimes mere textual material may not fully encapsulate the entire enquiry. With this concept in mind, many museums, especially in London, have incorporated multi-sensory installations that include the architectural use of the space, text interpretation, and audio-visual representations.

In most cases, museum curators expect these technologies to attract new visitors and increase the number of visits while also improving the educational role of the museum (Hall and Bannon, 2006; Economou, 2009; Marty and Jones, 2009). Hence, institutions have invested heavily in education-focused technologies to enrich visitor engagement in and interpretation of exhibits (Heath, vom Lehn, and Osborne, 2005, p.91). They base their expenditures on the belief that using the most state-of-the-art technology is the solution to engaging with their young patrons and the public (Meisner *et al.*, 2007; Pujol-Tost, 2011).

Although some studies (vom Lehn and Heath, 2005; Marty and Jones, 2009) have shown that the learning impact generated solely by these technologies is fairly minimal, it must be recognised that the technologies do not operate in a vacuum. As Meisner *et al.* (2007) further note, there is little understanding going beyond the human-computer interface—researchers do not fully understand the relationship between a visitor's understanding of learning in relation to her physical behaviours with a richly technological environment of buttons, keyboards, and touchscreens. Moreover, the museum experience is not a single-object interaction—rather, it consists of multiple

meaning-making processes, including communication between visitors, visitors' interpretation of the displays, and interpretative aids (discussed further in Section 2.5).

The other key influences on visitors, such as visual representations, sound effects, ambience, labels, and the physical actions of other visitors, should also be taken into account. Few studies have asked the fundamental question of why a participant behaves in a particular way, or have given an in-depth explanation as to how the usability of a technology may influence visitors' behaviour and whether that can enhance one's personal interpretation on the content of the exhibits and learn from such experience. Furthermore, it is difficult to understand a device's full potential impact on museum learning as a whole. This is to say that previous studies, although valuable, need to be interpreted and contextualised before they can be applied to today's setting. Thus, in order to explain the learning experience in museums, it is crucial to construct a more comprehensive model of visitor interaction, including a multimodal dataset, which will then allow us to create a more holistic understanding of the relationship between visitors, technological devices, museum educators, and exhibits. Therefore, the forms of visitors' interactions are key to understanding the overall impact of and the effect on the 'how' and 'why' behind individuals' learning experience in museums.

2.4 The relationship between engagement and learning experience

Engagement: Meaning-making processes

The majority of museum-based studies suggest that the forms of visitor

interaction have implications for learning. Still, not every interaction or encountered mode leads to learning. There seems to be a lack of justification, explanation, and understanding of the differences between engaged with and learnt from exhibits. For example, with the use of multimodal technologies, museums have shown an increase in engagement with the content of the exhibits, such as touching virtual objects on a screen, or watching and listening to a video related to the exhibits. But are the visitors simply interacting, or are they learning?

In this study, to fully understand what learning is in museums, it is important to distinguish between learning and mere interaction. Although related, the two are distinct concepts. Visitor interactions can be considered as processes of meaning making, but again, they do not necessarily equate to learning or to engagement.

Due to the abstract nature of individual experience, in order to contextualise students' understanding of learning in relation to their experiences, it is important to recognise the ways in which students formulate their processes of meaning-making in a museum context. This notion of the meaning-making process has been comprehensively discussed by Hooper-Greenhill (1994) in *The Educational Role of the Museum*, in which she indicates the complication of interpretation during a museum visit. She explains that an object contains multiple meanings, associations with both the past and the present depending on the individual's situation and prior experience. In a museum, on top of a personal level of interpretation, the given modes of interpretation from a museum, such as the textual labels,

activities, and videos, add another level of complexity to an individual's understanding of the presented material.

Visiting a museum is therefore not merely about information acquisition. Rather, it is a multifaceted interaction consisting of the constant interpretation and conceptualisation of meaning—the process of which can also be seen as 'experience'. All forms of visitor interaction, from touching objects to discussing exhibits with another person or in a group, are considered processes of constructing meaning and understanding. I would argue that the nature of museum learning consists of experiences, and that experiences can be constructed by learning. This reciprocal outcome may be one of the influences that in many museum evaluation reports and studies, which are full of buzzwords like 'motivation', 'engagement', 'meaning-making process', 'emotional', 'satisfaction', and 'inspiration'. These positive phrases are important factors, as Ormrod (2011, p.400) suggests that students are more likely to engage in meaningful learning with the content when they have more of an emotionally positive attitude.

Motivation and learning experiences

The motivation to engage with museum exhibits can come from the positive attitudes that result when individual visitors have the independence, willingness, and freedom to choose and control their own learning methods at their own pace (Csikzentmihalyi and Hermanson, 1995; Paris, 1998; Packer and Ballantyne, 2002). This relates to the concept of 'need of cognition' (Cohen, Stotland and Wolfe, 1955; Cacioppo and Petty, 1982)—the individual's enjoyment of thinking and structuring relevant preferences into a

meaningful understanding, depending on personal interest. I believe that visitors' inclination to explore, understand, and interpret what they see, hear, touch, and sense is part of the meaning-making process and experience, which may lead to learning. Like engagement and learning, experience and learning are interrelated and dependent on each other, but are not equivalent terms. There is much complexity behind a simple word, *learning*. Influential museum-based researchers Falk and Dierking (2000, p.33) state, 'Learning is never just facts and concepts. Learning, particularly intrinsically motivated learning is a rich emotion-laden experience, encompassing much, if not most, of what we consider to be fundamentally human. At its most basic level, learning is about affirming self.' They explain the importance of the 'process' of constructing one's initial engagement with an exhibit, and the later internal meaning-making process in assembling one's understanding, rather than emphasising the function of human memory. They also reaffirm the complexity of and the inseparable relationship between learning and experience. The close relationship of the two suggests the difficulty of precisely identifying the ways in which new knowledge is gained by learning (Rennie and Johnston, 2004).

One way to define the connection between learning and experience in this study is adopted from Weil and McGill's (1989) approach of experiential learning. They suggest that the learning experience consists of 'a process for making a judgment or decision, rather than focusing upon the outcome expected' (*Ibid.*, p.52). Weil and McGill note that in many cases, people make decisions unconsciously due to personal habits or common sense, which are

based on prior knowledge. Therefore, in the present case, looking at personal and social 'habitual patterns', such as utterances, conversations, and physical interactions, can be an efficient way to capture how individuals construct what they know and what they discover during their visits. Weil and McGill further emphasise that a habitual pattern 'provides a considerable measure of efficiency and enables one to do far more than would be possible if [one] made every decision with a conscious mind' (*Ibid.*). To this end, experience can be considered as an active and evolving process that could lead towards learning, but not necessarily a direct outcome or product of learning. Learning in museums is therefore not merely an acquisition of factual information. Instead, it could be suggested that learning is a developing moment of process as well as a product, and depends on the participant. Hence, the goal of this study is to explore this concept within this particular context.

Learning in a museum context

As mentioned, the focus of museums has gradually shifted to visitors' experiences, and the associated field of cognitive research has therefore broadened. Many social scientists have explored teaching and learning methods in museums (Hooper-Greenhill, 1994; Atkins, Goudy and Dunbar, 2008; Schwartz, 2008). Theories and models have been applied to demonstrate to museum professionals and schoolteachers the ways in which pedagogy can be effectively used. Learning in this context is largely informal, voluntary, and a 'mix and match' of interests, but it can also display some of the attributes of a traditional isolated classroom setting (Hein, 1998, p.7), such as during a museum activity with a museum educator. Still, museum visits are

unstructured; hence, there is no definitive theory or concept that truly encompasses every aspect of learning in museums. In this section, a variety of different approaches are described and analysed in order to reinforce the purpose and perspective of this study of the ways in which schoolchildren learn in museums.

The focus in this study is on young people—schoolchildren. Many researchers of museum-based studies with young people have aligned their beliefs with philosopher John Dewey's (1963) concept of the learning experience. Dewey (*Ibid.*, pp.27–28) believes that museums can motivate children's interest in learning and create 'the kind of present experience that lives fruitfully and creatively in subsequent experiences.' This concept of the learning experience corresponds with social constructivist accounts, which are extensively used in most museum-based studies, theories, and models on learning (Vygotsky 1978; Bruner, 1996; Osborne, 1998; Jeffery-Clay, 1998). Such studies assert that dialogue is the primary medium for knowledge construction. This idea is further championed by Vygotsky (1978), who suggests that constructing knowledge on a foundation of what one already knows depends on one's social interactions. Within the constructivist learning paradigm, learning is an active process and is grounded in how one's prior knowledge, concepts, and experiences relate to the new information presented (Bruner, 1966; Resnick, 1991). In the context of museums, learning involves scaffolding by self-exploring an exhibit, participating in a museum activity, and engaging in social, physical, and discursive interaction with other visitors.

Resnick *et al.* (*Ibid*, p.2) note that 'our daily lives are filled with instances in which we influence each other's constructive processes by providing information, pointing things out to one another, asking questions, and arguing with and elaborating on each other's ideas.' It must be remembered, however, that not every conversation or social interaction is a building block. Many researchers, such as Cotton (1995), argue that an important implication of constructivist theories is that one needs to consider the learner as one individual because of learners' different social and cultural backgrounds and prior personal experiences. Due to this factor, not every social interaction may be justified as a learning experience.

Another perspective on learning in museums is that cognitive development and conceptual change occur as a result of interactions between existing cognitive structures, such as visitors and exhibits, in a social context (Piaget, 1967; Hein, 1998; Jeffrey-Clay, 1998). The visitor takes new information into his mind from the environment. For this particular meaning-making process to happen, the visitor has to adjust his previous understanding and integrate the new information into the old. In the museum context, for instance, exhibits and interpretative labels form the new information for the visitor to assimilate into his current understanding. This building from prior knowledge is heavily emphasised in the literature. Within this framework, active discovery is principally encouraged to transform visitors' knowledge through the environment, the instructor, and the instruction.

This reciprocal constructing and reconstructing of one's understanding

and cognitive process was modified by Kolb (1984, p.28) into his theory of experiential learning. He stresses that 'the fact that learning is a continuous process grounded in experience has important educational implications. Put simply, it implies that all learning is relearning…One's job as an educator is not only to implant new ideas but also to dispose of or modify old ones.' To fortify this continuous learning process, researchers have found that shared and group experiences provide an effective means to create engagement and participation with museum exhibits (Grinter *et al.*, 2002; Heath *et al.*, 2002; Meisner *et al.*, 2007). Indeed, learning in museums is heavily socially oriented. The social context reinforces the learning process since an individual's thinking occurs during his active participation in real situations.

In addition to the social, cultural, and constructive aspects of learning, in *Learning in Contemporary Culture*, Curtis and Pettigrew (2009, p.160) summarise the 'Postmodernist' position adopted by Lankshear, Peters and Knobel (2000), which suggests that knowledge in the digital age is constantly evolving and organic, and is a basis of on-going contestation: 'a source of disagreement, argument and speculation'. Indeed, there is no absolute certainty of the truth; hence, knowledge should be conceptualised as progressive and unrestrictive (Curtis and Pettigrew, 2009, p.43). Learning in museums can be justified as part of this process of meaning-making about knowledge, given such a malleable and evolving concept of knowledge. It is this meaning-making process that connects to engagement and learning in museums.

The question here is to explore 'how' these engagements are related to

learning, if they are related at all. For instance, with the increased use of technologies, such as single-user touchscreen interfaces or handheld audio tour devices, learning in museums has become more isolated and individualised. Therefore, the social constructivist theory may not apply in this case. At the same time, the physical momentary attention to or interaction with an exhibit without any cognitive development can sometimes be misinterpreted as learning. Moreover, the adoption of multimodal technologies in this study does not connect directly with 'multimodal learning' (Kress, 2001) or a 'multimodal learning environment' (Moreno and Mayer, 2007). Although these terms in general denote learning though multiple means of engagement, representation, and action, this study focuses more on the combination of visual and verbal representation. Many researchers have discussed the potential inherent in providing rich resources and multiple modes of representation, postulating that this can increase students' interactions and engagement with the learning materials, and particularly with their school curriculum (Moreno and Mayer, 2007; Renkl and Atkinson, 2007; Fadel *et al.*, 2008). Yet learning, especially in a museum context, is not merely achieved by touching a screen, reading text, or looking at a picture. This study focuses not solely on engagement or learning, but on the relationship between the two through the use of the technologies and the environment.

This study aims to look closely at these interactions in relation to the participants' interpretation of their actions and their cognitive development that may constitute learning, and not every theory can be adopted for use in this context. It is also essential to use appropriate methods to explore the

effectiveness of multimodal technologies in creating and enhancing learning opportunities, and the ways in which exhibits inspire visitors' interpretation in a social, technological, and educational context. The attention given to a particular interaction should be tailored depending on the context of the museum and the distributed material, such as an activity, technology, setting, or audience. To enable this, a qualitative and detailed method should be used, which will be discussed in the coming chapter.

2.5 Conclusion

The mission and function of a museum is to communicate information, preserve objects, and provide engaging environments in which visitors can experience cultural and scientific heritage. The challenge for museum professionals and researchers is that it is difficult to capture and distinguish between engagement and learning experiences. Given visitors' differing social and economic backgrounds, various factors may influence their interest and behaviour during their visits. While this concern is not fully resolved, many museums have turned to new technologies, particularly digital personal devices and sensory-based technologies, to make access to learning resources more immediate and ubiquitous. The use of these technologies is believed to create a more approachable way for the younger generation to engage with exhibits, especially schoolchildren who come to museums on field trips, which blend formal and informal learning (or non-formal learning) resources.

What is lacking, however, is a detailed explanation of how visitors'

modes of behaviour in museums relate to their surroundings and to the available technologies. This lack of detailed understanding of the mechanics behind visitors' engagement with the devices and their learning experiences has led museums to invest in the most state-of-the-art technologies without fully exploring their functions and effectiveness.

The present study contributes an in-depth exploration of how school students engage in learning activities in a museum using multimodal technologies beyond the formal context of the school. It provides comprehensive ways in which visitors, particularly schoolchildren, interact with the provided sensory-based technologies and discuss their experiences with their peer group. A simple response of 'It was interesting' on a survey, a distant observation, or a sole post-visit interview cannot fully capture the students' thoughts and interactions during their visit. Thus, a multimodal approach is key to this study and others like it.

This study takes Weil and McGill's (1989) view that learning in a museum is a constant process for making judgments or decisions, which also echoes the concept of the meaning-making process. Therefore, this study explores unreservedly how students interact with multimodal technologies, museum activities, and other visitors. In addition, the use of multimodal analysis (Section 3.5) is adopted to help fill the neglected breach in the literature on students' interactions with multimodal technologies alongside the rest of the museum exhibits and their peer group, and the consequent effects their perceptions of the relationship between engagement and learning experience.

Chapter 3: Methodology

3.1 Introduction

The literature review chapter showed that there is an important need to understand in depth on how individuals engage with the exhibits and learn from museums. One way of doing so is to conduct a study investigating the interactions among visitors, education-oriented devices, and surrounding displays. The focus of this chapter is, therefore, to lay out the rationale for and methods of this study regarding the decisions behind the selection of museums, participants, and technological devices. This chapter begins with a reiteration of the study's research questions, emphasising and explaining the multifaceted data-gathering methods, procedure, and data analysis approach. This chapter also discusses the problems, concerns, and limitations encountered during the data-collection process.

This study was designed from and based on two pilot studies conducted in 2009 and 2010. All decisions and practices in such studies should follow the ethical guidelines set out by BERA (2004) in light of the research questions and the chosen methods, and all attempts have been made in this study to maintain BERA compliance.

3.2 Rationales and principle underlying the methodology

As previously discussed, to better communicate with the visiting public, museums have made a huge investment in the use of new digital technologies. Many have incorporated multi-sensory installations that include

the architectural use of the space, text interpretation, and video and audio representations. In most cases, museums have justified their expenditures on the belief that using the most state-of-the-art technology is the solution to engaging with children and teenagers. Yet this belief may be misplaced, as most museum-based studies have shown little learning impact when only technology is considered. In general, these studies tend to look at satisfaction surveys, in which visitors describe whether a device is simply good or bad without providing clear justification. More researchers have adopted a qualitative approach in the last decade, however, which suggests that a study is needed to explore the 'why' and 'how' factors in this field of research.

The main problem with previous studies is their focus on single elements taken out of context. Focusing on only one facet of the experience means that other potential influences on visitors—such as sound effects, the ambiance of the space, labels, and the actions of other visitors—are ignored. Few researchers have asked the fundamental question of why technological displays work or fail, or have given an in-depth explanation as to how the usability and accessibility of a technology may influence visitors' learning behaviour, and so it is difficult to understand or foresee a device's potential impact on visitors' engagement and learning. Therefore, previous studies, although valuable, need to be interpreted before they can be applied to today's setting and help us analyse the learning experience in a more qualitative and in-depth manner.

It should be noted at the outset that this study does not intend to answer the question of whether technology should be used in museums, but

rather to aid in understanding how and why visitors use it. One focus of this thesis is to look into the relationships between museum visitors' interactions with technologies and exhibits, and their social interactions with other visitors. By doing so, the study investigates the role of technology, especially technology-driven multimodal exhibits, in museums. It explores the ways in which these devices can provide an enhancement in supporting students' interactions with other exhibits. Most of all, it looks at how these interactions relate to learning, or whether they are simply episodes of engagement.

Fundamental to this study is the fact that a museum experience is not merely a single object interaction—it consists of multiple interactions with information and communication among visitors, displays, and interpretative aids. Thus, in order to explain a learning experience in a museum, it is crucial to construct a more comprehensive, multimodal dataset, which will allow museum curators and developers to create more holistic interactions among visitors, technological devices, museum educators, and exhibits.

3.3 A qualitative and multimodal analysis approach

This study's research questions are designed to explore any specific behaviour or changes evoked by the modes that are incorporated in the technological devices and in the rest of the museum visit. Such learning experiences are formed by interconnected individuals and by the social behaviours in people's perceptions and observations—behaviours that are difficult to replicate accurately in a laboratory. The research design should therefore be based on a realistic setting and take a qualitative approach.

Gubrium and Holstein (1997), for instance, believe that being true to the nature of the phenomenon being investigated provides a realistic interaction and rich descriptions; in other words, using a real-life setting minimises researchers' tendency to draw inaccurate conclusions. Silverman (2005) comments that a qualitative approach has strong potential to reveal real-life complexity. A quantitative pre- and post-test or a multiple-choice questionnaire is simply not detailed enough to measure the intricacies of human learning, especially in such a mobile, active, and complex learning environment as a modern museum. Using words and observation in close proximity, such as an interview, offers us greater opportunities to understand the potential 'why' behind participants' perceptions. By using a flexible and open-ended approach, this study can perhaps pull unexpected data from the expected results.

Maxwell (1996) states that the major strength of qualitative research lies in capturing the processes that lead to certain outcomes. The details of the process are therefore just as important as the outcome. Qualitative methods assist researchers in examining the quality of the collection process and produce more comprehensive content with an effective tone of truth (Miles and Huberman, 1994). Given the importance of the collection process's quality, a multimodal analysis approach is adopted in this study to enrich our understanding of and contextualise the individual experience, and produces a more comprehensive interpretation.

The core concepts of multimodal analysis (which will be further discussed in Section 3.6) are still in a changing state, depending on the

different approaches of researchers (Jewitt, 2009, p.21), which has produced many interpretational problems. Put simply, however, multimodal analysis raises the question of how one can determine that a certain gesture made by a certain individual denotes a certain meaning. This raises the possibility that a researcher can make subjective interpretations, thus changing his role into that of a psychoanalyst. This study, therefore, cannot be solely based on multimodal analysis, but must combine it with other qualitative research methods, such as using interviews to validate the conclusions drawn from observation and interpretation.

3.4 Research questions and design

Research questions

This section narrows the study's broad aim and rationale into research questions and a design. This study explores the role of multimodal technologies in museums and attempts to develop an in-depth understanding of how schoolchildren engage and learn in museums. The role of the research questions in a qualitative study like this is to provide a clear conceptual strategy and framework while retaining the flexibility to permit the unanticipated to emerge (Marshall, 1999). Research questions are, in a way, the theoretical framework for the research process, allowing the researcher to collect, analyse, and interpret information in a meaningful fashion. The questions are carefully formulated as a systematic infrastructure for data gathering.

In this study, the overarching question of this study is as follows:

What is the relationship between engagement and learning in school students' interactions with technology-driven multimodal exhibits in museums?

The overarching question is then divided into two operational questions to refine the focus. The goal was to find out how students have interacted with the device and the kind of learning that takes place. They are:

1) In what ways are school students engaged by technology-driven multimodal exhibits in museums?

2) To what extent and in what ways do these engagements result in experiences of learning?

Here the overarching question was designed to lay out the initial structure, identifying the broad context but also pointing toward a focus for synthesising findings. As suggested in the previous chapter, however, the lack of similar research methods in the field and the problem of generalising individuals' experiences led to difficulty in producing guidelines to capture unforeseen outcomes.

A researcher must be careful that the sense and wording of a question determines what one intends to learn or value (Holloway, 1997, p.138). For instance, the question and research design are dependent on each other, as without a feasible process, the question cannot be formed, and without a practical question, it is difficult to conduct the chosen process. This reciprocal interaction between question identification and development of the process

seems to be the prerequisite for most experimentation (Punch, 2005, p.44). Therefore, the wording of the overarching question was chosen to be exploratory. The use of the term *relationship* is a deliberate act to retain the flexibility and unrestricted nature of the findings, as individual students' constitutions of engagement and learning are open questions themselves. This question can relate to various aspects of a student's visit, such as the museum activity, the chosen multimodal technologies, the influence of schoolteachers, and the museum's collection. Moreover, the constitution of the museum experience of learning in itself is another question to further explore.

The format of the first operational question reflects Andrew's (2003) suggestion that research questions are important factors in the choice of methods. He emphasises that the question must be answerable in order to conduct research and maintain the reliability of the research method. This question is designed to explore different 'ways' students interact with exhibits, and especially with the chosen multimodal technologies. Multimodal analysis is used in order to do so (see Section 3.6), and semi-structured interviews with museum professionals (*e.g.*, designers, curators, and educators) and schoolteachers are used to support the observation of these students' interactions.

The second operational question was designed as a sub-question to feed additional direction to the stages of analysis, asking whether it is possible to relate previous visiting interactions and modes of communications to an individual's new or previous knowledge, thereby leading to learning. This

question is not formulated with a specific answer in mind. Rather, it is made part of the research design in order to show potential linkages between engagement and learning. The open-ended phrase ‘To what extent and in what ways’ is used to provide more possibilities for the students’ interpretations and conceptions of engagement and learning from their semi-structured and stimulated recall interviews. An auxiliary aspect of this question is the consideration of how time may be an influential factor in a student’s combination of learning and experience into a learning experience. The span of time is defined as longer-term here after at least six months; although this is not an extensive time period, due to the time limit on this study, it must suffice.

The combination of the two operational questions feeds directly into the overarching question. The first question explores the ways in which school students engage and interact physically with multimodal technologies and the environment. It delivers the initial overall picture of the students’ interactions. The second question offers the students’ perspectives on the ways they think they engage and learn from the exhibits. The phrase ‘in experiences of learning’ rather just ‘experiences’ or ‘learning’ is used here because visiting the museums for the students is an experiential process, which can result in either learning or simply as an experience, depending on the individual student. However, before a student ever learns, he first has an experience through engagement with the exhibit. Therefore, instead of deciding whether the students have learnt, it may be necessary to leave this particular

operational question open as some students may not experience anything, or even engage at all.

Research design

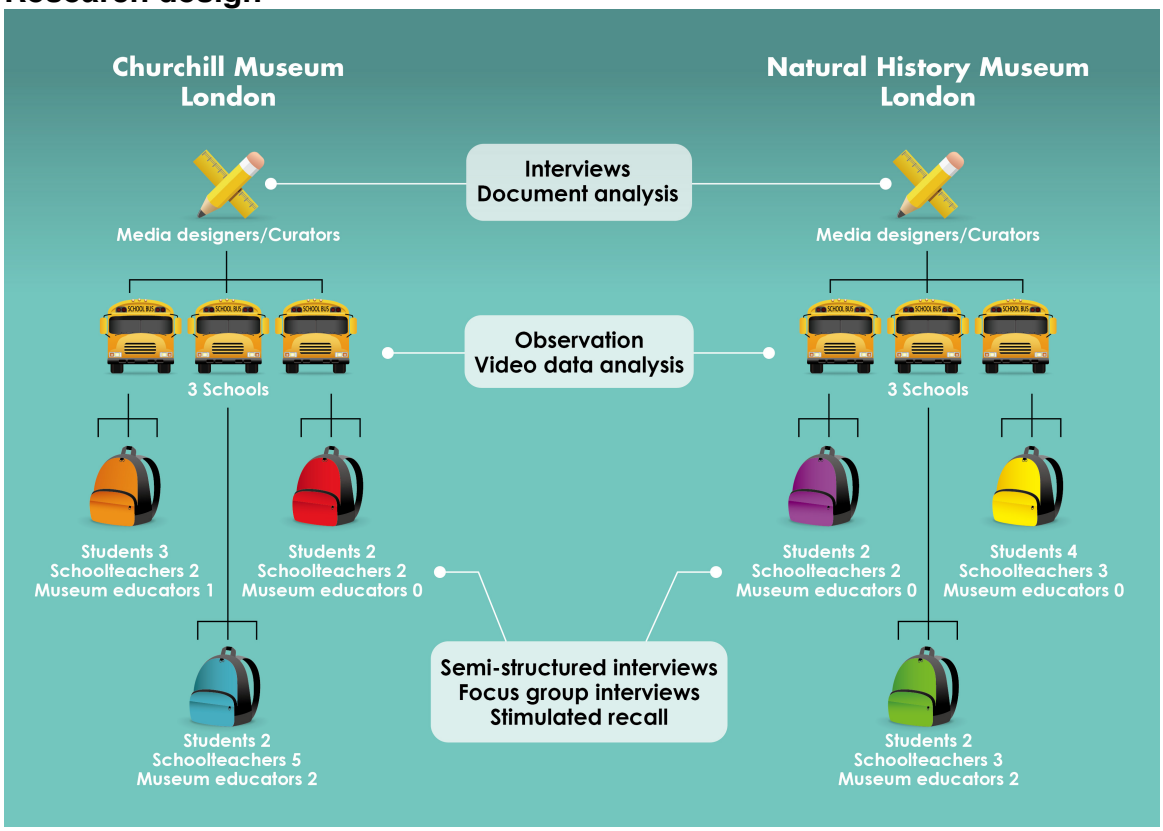


Figure A: Research design

Drawing on the research questions, a framework was designed for the collection and analysis of data (see Figure A). Yet, prior investigating the study, it is important to understand museums' initial strategies and objectives in developing interactive digital hands-on devices and programmes. Therefore, a series of informal interviews was held with museum designers, curators, and directors. The intention of these interviews was not to evaluate the technologies or the museum, but rather to understand the basic rationale for implementing the devices and to gather necessary background information

about the context, which also helped answer the overarching questions.

The two museums, the Natural History Museum, London, and the Churchill Museum, are separate cases, but they are used together in one empirical study, the ramifications of which will be later discussed (see Section 4.4). Each museum provides a similar style of activity that relates to the chosen multimodal technologies, and both museums allow students to explore the device along with the rest of the exhibits

At each museum, I observed groups from three different schools on field trips on separate days. Each group consisted of 25–40 students, and the ratio of students to teachers was roughly five to one. During each school's visit, which would normally last an hour, two to four students were chosen randomly for observation and video filming. Thirty-minute interviews with students and a teacher group interview were conducted a week after the visit. For the student group, an interview technique of stimulated recall (here, reviewing a selection of video clips to stimulate students' thinking and memory) was utilised as part of the semi-structured interview. The general interview questions for the students were focused on their individual and group experience in the museum with the use of technology, especially the multimodal technologies and the surroundings. For the schoolteachers, questions centred on their observation and personal experience before, during, and after their visits.

There was an additional semi-structured interview carried out at least six to eight months later with the selected students and an additional open-ended survey conducted with the rest of the class. Although only two to four

students were chosen during the first phase, this class-wide survey was critical: The students chosen during the first-phase visit would be more likely to prepare something to impress the researcher or present for the second-phase interview, which would be counter to the purpose of capturing the natural traces of their museum reminiscence. Therefore, the open-ended survey given to the rest of the class was designed to present more realistic findings. The survey was completed within ten minutes as part of the students' task during a class. The hope was that by giving this survey to the rest of the class, any differences between the class and the selected students would emerge.

Overall, there were 179 participants. Fifty-four students took the last open-ended survey six to eight months after their visit; fifteen students participated in the video filming and stimulated recall interviews. Seventeen teachers, seven museum designers, and three museum educators took part in the semi-structured interviews. The final participants and schools were chosen due to the availability of the students and teachers for both video recording and interviews as well as the clarity of the video analysis (see Table 1).

Natural History Museum

Time	Jul-10	Aug	Sep	Oct	Nov	Dec	Jan-11	Feb
Number of schools	1	0	0	3	0	2	1	4
Total students booked for the event	40	0	0	90	0	63	30	135
Filmed Students/Teachers	15+3	0	0	32+4	0	21+2	9+3	28+3
Museum Educators	0	0	0	1	0	1	0	0
Interview 1	18	0	0	27	0	23	12	25
Interview 2 (6–8 months later)	7	0	0	16	0	0	4	17
Surveys	7	0	0	4	0	24	5	4
Total used (Students/Teachers)	4+3	0	0	2+2	0	0	0	2+3

Churchill Museum

Time	Jul-10	Aug	Sep	Oct	Nov	Dec	Jan-11	Feb
Number of schools	2	0	0	1	2	3	0	3
Total students booked for the event	40	0	0	60	32	60	0	64
Filmed Students/Teachers	10+3	0	0	8+2	7+1	15+3	0	30+5
Museum Educators	1	0	0	0	0	0	0	0
Interview 1	13	0	0	10	8	18	0	26
Interview 2 (6–8 months later)	5	0	0	4	4	8	0	2
Surveys	31	0	0	10	19	3	0	7
Total used (Students/Teachers)	0	0	0	2+2	0	2+2	0	2+5

Table 1: Summary and timeline of the study

In the museums chosen for this study, as in most museums, the setting and devices were designed for the general public, not just for children. It is always important to use a broad scope of participants in studies, but because the aim of this particular study is to observe details of people's understanding and interactions, a small-scale project—here, a project involving controlled groups of children—was most feasible. As Silverman (2005, p.9) points out, 'Qualitative research design tends to work in a relatively small number of cases . . . . [R]esearchers are prepared to sacrifice scope for detail.' This focus on minimising the number of participants in each group may make the decision to use two museums in one empirical study seem counter-intuitive, as the multiple locations may seem like too much for such an in-depth study. In particular, using two museums may lead to many potential variables and differences, which in turn may present concerns for the study's validity.

Still, concentrating on a smaller numbers of participants from each school and comparing their behaviours provides detail and richness, and concentrating on the twenty-four students in this study was therefore a sensible and suitable option. Consider Maxwell's (1996, p.17) statement that one should 'not only just be interested in [participants'] physical events and behaviour . . . but also in how the participants in your study make sense of this and how their understanding influences their behaviour.' This statement works with the multimodal analysis approach, yet raises a concern about overwhelming detail and irrelevant information interfering with the main purpose of the study. To address this concern, a careful, selective, and

transparent data collection and analysis process was used throughout the study.

To further limit the scope of the study into a manageable project, the student participant age group was narrowed down to generally match those of the pupils in Key Stage 3 and 4 (year 7–12) students, aged 11–16. They were of a sufficient age to have completed their primary science and history education and to have acquired basic knowledge of general science from their school curriculum. There were also two slightly older students in the same year group (ages 17–18), who participated in this study, which is only a minor aberration in the data set.

3.5 Deconstructing learning experiences by diverse methods

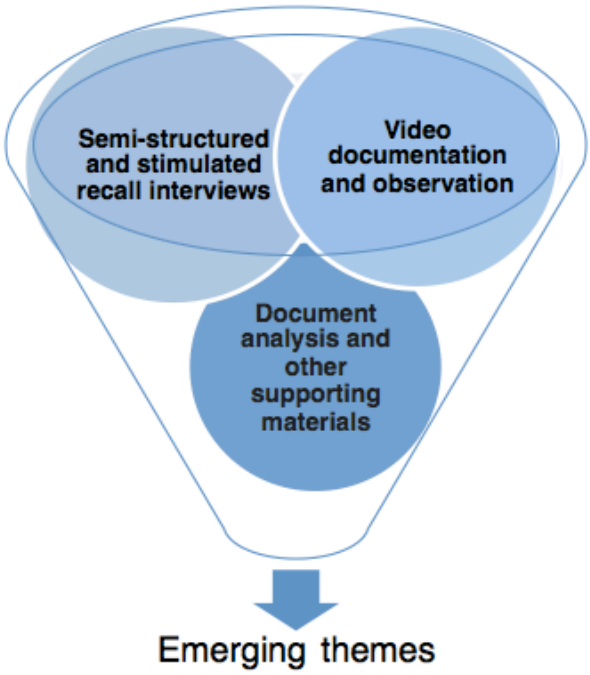


Figure B: Diagram of data analysis

Understanding an individual's experience is not a straightforward process. To unfold the layers of complication, this study used a combination of different data collection methods. As seen in Figure B, data from the various participants, collected through diverse methods, showed many asymmetries in perspectives, which adds to the holistic and in-depth aspect of the study. Several problems arose because of the adoption of multiple methods, however—not only the difficulty of coding a vast amount of complicated data, but also the great deal of time needed for video and audio editing and recording, on top of transcribing the interviews. The following sections discuss the rationale for the methods used and the issues encountered during the study.

Video documentation and observation

As Hammersley (2010) points out, since the 1960s an increasing number of qualitative researchers have used video recording and transcription to replace field notes. In his opinion, video data has been taken for granted and field notes are now treated as second-class data. He emphasises that field notes, in one sense, provide a more accurate representation of what happened at the time rather than what we later think happened or interpreted.

The opposite case can be argued for the same reason, however. Video data has been described as a dense, reliable, and permanent form of data; the captured details can go beyond human observation, and the record is permanent—it can be easily repeated or retrieved with the possibility of

reinterpretation (Bottorff, 1995; Glesen, 1999; Plowman, 1999). Many researchers, such as Pea (1999), believe that video data is a new media communications forum for improving education research and practice. This belief has been encouraged by Walker (2002), who suggests that one should engage with new genres, such as visual evidence, moving beyond textual forms of research dissemination to something more rigorous, with a strong sense of direct presence with the phenomena studied.

This methodological tool aids the transcription and analysis because it includes body language and 'silent' language. Visitors' interactions in museums are not purely textual language communication—interactions with the space, video projection, music, and sound effects are becoming the dominant forms. Therefore, video data can provide the researcher with valuable information in conjunction with text-based transcriptions. In a way, this can create an effective way of illuminating the study's results that might not otherwise be obtainable (Kearney, 2006).

On the other hand, although video documentation is often associated with the true-to-life approach to collecting data, it is impossible to capture 'natural' behaviour while having a camera intrude upon subjects' interactions. There is a legitimate concern in video studies about the 'Hawthorne effect': When people know they are the subjects of an experiment or a study, they will behave differently in such a way as to produce results that would not occur under ordinary conditions. The presence of a researcher may change any setting to be observed. Yet Bogdan and Biklen (2003) suggest that the novelty of an observer or a video recorder in the classroom can disappear after a

short period of time. Unlike a classroom setting, however, the problem with filming in a museum is that a museum visit is an active process. To minimise this problem and make the participants more at ease, they were informed about the nature and purpose of the study to help them 'act naturally' and avoid being distracted by the video equipment. Even still, it was important to track the students unobtrusively so as to influence their behaviour as little as possible.

Another overlooked issue was the busy and crowded nature of museums. An ordinary video recorder cannot simultaneously identify the four participants and exclude all background noises. The solution for this was to ask the participants to carry an additional voice recorder, which later was matched to the video and voice data during transcription and analysis. The matching process was more time-consuming, but in many cases, it captured more dialogue than the video data and added another dimension to the data. As can be imagined, tracking four participants in a hectic museum with a video recorder can be challenging. Therefore, in a way, this method was crucial to improve the quality of the research and account for the challenges.

Semi-structured interview

To supplement the video data, a twenty- to thirty-minute semi-structured interview was conducted, using a group interview technique, to interview all the participants in groups: teachers, museum educators, and students. For the students' interview, the first fifteen minutes was spent in casual conversation about their visiting experience to understand their expectations, opinions, and interests. The second part of the interview was

conducted through stimulated recall by showing selected video data to the participants to stimulate their thinking, but also by matching the observed body language with what they were actually doing. Another semi-structured interview was conducted three months after the first interview to answer the last part of the research questions.

The strength of adopting semi-structured techniques, according to many researchers, is that it can ensure that data generation remains focused on research questions while allowing researchers to pursue avenues of concern or to probe respondents for clarification (Brown and Mclntyre, 1993; Kvale, 1996; Cooper and Mclntyre, 1996). As Riesman and Benney (1956, p.225) state, '[S]ocial life generally—is asking and answering questions all the time, whether or not this process is formalised and termed an interview.' This is true to the extent that the underlying nature of an interview is a form of discourse, a representation of a talk that is simply shaped and organised by asking and answering questions (Mishler, 1986).

The 'semi'-informal technique allows the interviewee to be more at ease, and dialogue will therefore be richer and more spontaneous. Due to the flexibility of the conversation in this study, I was able to explore the students' comments and meaning-making by asking them to give more examples, definitions, and explanations. Regarding obtaining qualitative data through interviews, Silverman (1993, p.91) states, 'The primary issue is to generate data which give an authentic insight into people's experiences', and understanding these experiences is the main goal of this study. Here, using a sequence of casual questions, the observed behaviours could be correlated

with the descriptive video data. This approach allowed me, as the interviewer, to have greater freedom to conduct the interview while giving me more time to compare observed actions with participants' thoughts and attitudes (Powney and Watts, 1987). Interview data can offer additional validation to enhance data interpretation, particularly addressing the two operational questions on how different observed modes of behaviour match individuals' opinions and thoughts.

As a researcher conducting an interview should be an active listener, he must 'set aside [his] assumptions' and 'seek explanations about what they mean' (Glesne, 1999, p.83). During the interviews in this study, open questions were generally used to avoid predetermined outcomes and allow opportunities to explore unanticipated issues. This flexibility created a friendlier atmosphere for the students, who were free with their opinions (Kvale, 1996, p.145).

Group interview

The thirty-minute student interviews mentioned above were conducted with the chosen group participants (N=2–4). Each participant presented his own views and experience, but also listened to the other students, and sometimes reconsidered his own viewpoints. The dataset is a collection of individual interviews. In a sense, using the group dialogue to seek clarification is important to justify this method (Ritchie and Lewis, 2003). I believe this method also gives insight into individual views, however; individual opinions and beliefs may not always be compromised, and sometimes, interviewees may express personal statements without being truly involved in the

conversation. Still, a group interview can be regarded as a more true-to-life method than individual interviews, as 'participants are influencing and influenced by others—just as they are in real life' (Casey and Kreuger, 2000, p.11). Indeed, the social setting provides a more naturalistic conversation, including elements such as collective and individual self-identity and shared meanings about how participants experience and understand the world (Bloor *et al.*, 2001).

To structure the discussion, one must bear in mind its organic progression. It is necessary to impose some structure to ensure that the discussion touches on the research questions while retaining its openness. In this study, particularly with young students, it was necessary to keep the discussion on topic and take care to avoid permitting one participant to dominate the interview and impose his views on others. In most cases, this method was useful. I found that the flexibility of the method allowed me to encourage in-depth and diverse explorations of emergent issues with the students.

Stimulated recall interview

Hammersely (2010) points out that video recording enables researchers to study human social interaction in a more scientific way, since the video data can almost 'freeze' the moment of time. However, he adds that the researcher's description of video data can become too subjective. In essence, with video, the researcher has to guess or make predictions about the participant's body language, whereas the simple text from a transcription presents more concrete 'evidence' from the participant. Therefore, I argue for

the importance of using stimulated recall to support and validate the observation and video data in this study.

Stimulated recall has been used extensively in research into teaching (Krause, 1986; Allison, 1987; Butefish, 1990; Dunken *et al.*, 1998; Chittenden, 2002; Schepens, Aelterman and Van Keer, 2007). In general, this technique involves interviewing the participants while playing audio or video recordings of their own behaviour in the social setting. This method creates stimuli for the participant, allowing him to review and remember his behaviour from a third-person perspective. It is not designed to test participants' memory, but rather, it allows the researcher to decipher unique insights into the 'motivations and strategies underlying interactions and practices' (Dempsey, 2010, p.349).

In this study, participants were asked to review five minutes of their video data whilst describing and explaining what happened during that time. This interview was then audiotaped and transcribed. A similar approach has been used by many social science researchers (Schepens, Aelterman and Van Keer, 2007). This technique especially matches the semi-structured and group interview, as it guides the participants within the research topic whilst giving them concrete visual material to use in discussing their opinions and behaviour. Moreover, the mode of 'watching' what they were doing provided a more spontaneous and relaxed interview atmosphere, which reduced the traditional formal interview questioning tension. This practice also helped meet the BERA (2004) requirement that the experience of participating in research should be as anxiety-free as possible.

The stimulated recall was not used until the second half of the

interview, which created a useful comparison between what I observed and what the participants experienced. This method unfolded the participants' language and thoughts, but also confirmed my observations and analysis.

Document analysis and other supporting material

The study began with interviews with the multimedia teams. In addition, I analysed the existing data on the supporting documents for the design of the device, allowing me to closely explore the existing questionnaires, evaluation forms, and any related documentation provided by the museums. This gave me a thorough understanding of the initial policies and objectives of the museums and their learning departments, which correlated with the type of questions that I formulated during the interviews. I was also able to use some of the questions from the teachers in understanding the purpose of the devices and how teachers can use them to improve their students' learning or answer their students' queries in the future.

The last part of the data was derived from the visual documentation, which was produced by the students during their visit or activities. Both museums provided a semi-formulated activity that worked with the theme of the museum. During the activity, in some cases, students would be asked to write something down on a piece of paper or type certain information onto a computer screen or a digital surface. People write something down to signify its importance; therefore, I studied each student's documentation in comparison with the interview data. These elements, considered together, elucidate the complexity of the social interactions and the students' mentality. Morgan and Krueger (1993) emphasise the danger of oversimplifying human

motivation, and hence, by comparing different points of view and gathered materials, my aim was to collect complex data suited to the task. This material was considered as a supportive element on top of other methods.

The aforementioned open survey is a simple question on a piece of blank paper asking all the students to either write about any related event or draw related material that they have encountered during the three months after their museum visit. This part was designed to show the differences between the four students from the first interview, who might have prepared for the second-phase interview to please the researcher, and the rest of the students, whose reactions might be more genuine.

3.6 Multimodal data analysis

This section explains the rationale of how and why the collected data were reduced and analysed, followed by the format of how they are reported and presented. The data were derived from a variety of sources, including interviews, video data, and students' documents.

The initial step of the analysis began with transcribing all the interview data and dialogue from the video data. The interview data included group conversations and stimulated recall dialogue. The analysis was an inductive process, as the descriptions and comments about the participants' experiences produces rich inductive material. This material was then classified, connected, and described using Miles and Huberman's (1994) coding methods. The raw data were divided into groups of similar phenomena, such as similar usage of modes. These fragmented categories

were then connected to create links and subcategories. Each classification is clearly defined and associated with an example quotation from the interview and observational notes. One must bear in mind that coding is an endeavour that seeks to fix meaning, representing the researcher's thinking process about how the data should be interpreted, and thus, a constant comparison of these categories and subcategories will gradually emerge to generate theories that relate elements into an assumption before finalising conclusions (*Ibid.*).

Although the coding and analysis are not based on grounded theory, certain elements are similar to Strauss and Corbin's (1990, p.90) systematic comparison method of analysis. The data were derived from more than one method, and different sets of data were constantly compared, constructed, and deconstructed throughout the analysis. The assumption is that the two sets of data are related to the students' drawings or documentation. Each document was analytically described and placed within the other categories, constructing a clear visual overview for readers. By combining the data from both the utterances and the visual representation, a more in-depth and holistic picture of the students' interpretation of learning was generated.

A crucial component of this study's analysis is similar to Multimodal Interactional Analysis, which Norris (2004, p.4) defines as a way 'set out to understand and describe what is going on in a given interaction.' Indeed, interaction is an on-going and co-constructed situation between individuals' expressions and reactions. He further stresses that:

> Communicating is interaction if one person conveys a message

> and another person perceives it. The modes utilized for interacting do not create a communicative moment as an interaction, but rather the process of doing something to or for or with people allows us to understand a communicative moment as an interaction.

(*Ibid.*, p.149). Jewitt (2009, p.34) reiterates Norris's point that multimodality expands from the traditional text-based context, and postulates that language is only one of the resources of the meaning-making processes. One should also include gestures, gazes, postures, movement, spaces, and objects to understand a situation in context.

The video data were therefore essential in answering the first operational question. The aim of this analysis was to generate and scrutinise multimodal data, looking at, for instance, the use of touch or facial gestures as part of the interaction between the students and their learning environment. The advantage of adopting multimodal data analysis is that it provides multiple layers of evidence to be contextualised in a broad scope, such as using a photograph and description from someone to understand an event, but also a microscopic scope, such as using a particular facial expression in the photograph to illustrate the ambit of social interaction more holistically. It should be remembered while analysing video data, however, as Baldry and Thibault (2006, p.165) mention, that 'the process of making a video recording . . . and its subsequent viewing is itself an act of selective re-contextualisation of a prior semiotic event.'

Indeed, reviewing, selecting, and editing the video data into segments of scenarios is already an analysis process of its own. Allan (2002) notes that photographs extracted from original video data can be important sources to support readers with valuable visual information in conjunction with text-based transcriptions. The multiple representations and interpretations, in a way, form a combination or juxtaposition of different research techniques, which I believe helps researchers connect layers of reoccurring themes and evidence to an understanding of behaviour in a more rigorous yet objective way.

The complexity of the highly visual, audio, and kinaesthetic nature of the multimedia data fragmented the representation of the findings, however. Many researchers still find this issue of how to capture, analyse, and represent multimodal data unresolved and underdeveloped (Plowman and Stephen, 2008; Flewitt, 2006 and 2011). To further a deeper understanding of the data context, many multimodality researchers, such as Flewitt (2011), argue for the potential of implementing an ethnographical approach on top of the multimodal data. Although the compatibility of the two has the potential to contribute toward findings, this combination is still evolving and is unstable for purposes of social science research (Kress, 2011). The video data in this study were thus informed by many multimodal analysis studies (Baldry and Thibault, 2006; Lancaster and Roberts, 2007), but in particular by Flewitt's (2011) combination of embracing ethnographical approaches.

The presentation of the data begins with a photograph showing the geographical and physical layout of the hands-on sensory device in relation to the rest of the museum exhibits. A brief description of the students' overall

touring movements accompanies this image. Here, the intention is to elucidate for the reader the spatial positioning of the students throughout their visit. This is an initial and essential part of the data analysis, and builds a clear image of how the arrangement of the exhibit and the mobility of the students functionally and symbolically interact with and influence each other. This architectural use of and access to space is believed to be an important factor in shaping one's social and cultural relationships and perceptions for learning (Kress, 2009; Flewitt, 2011). As with Flewitt's (2011) research, a narrative episode of a scenario was chosen from each group to portray a detailed account of the students' visit. There are six such scenarios in total, three from the Natural History Museum and three from the Churchill Museum.

Each scenario is based on an extract from one student group. It included features such as turning up the media sound, dialogue, body movements, and gestures into a written format (Flewitt, 2011, p.302). This is then validated with the photographic documents (students' activity sheets or the photographs they took), interview transcriptions, and video transcriptions. In a way, this approach to analysis provides a more social semiotic dimension.

The term *social semiotic* refers to the way people use signs to communicate social and cultural circumstances, to create 'communicative artefacts and events and interpret them . . . in the context of specific social situations and practice' (van Leewen, 2005, preface). It therefore allows me to understand and compare different styles of meaning-making processes by the students, examining different behaviours in relation to the overall learning

experience and the technological device, and what the students expressed during the interviews. More importantly, it reduces the subjectivity from the observer's perspective and gives the reader a sense of 'being there' (Flewitt, 2011, p.302).

Hammersley (2010, p.558), however, argues the opposite, as he believes that video data allow a researcher to become a 'provider', or almost a creator. To simplify his arguments, he stresses that video data provide more than a simple matter of turning speech into written words. The language beyond sound—the facial gestures and body movements—makes meaning come from the researcher, instead of making the researcher construct the truth with the participant. Indeed, an over-simplified interpretation of data presentation, such as physical modes of action or dialogue alone, could only constitute the 'surface' rather than a deeper and more holistic insight into the story. The researcher in that case would thus take on a more active role to maximise the 'thin' findings. Consequently, the study would be criticised as being less objective. Hammersley (*Ibid.*, p.567) further emphasises that 'too much detail will obscure relevant data and how it relates to the knowledge claims being made.'

In this study, however, the use of stimulated recall was particularly chosen to prevent such issues and to increase the validity of the research. It is important to combine all of the methods used to assist in the creation of a more concrete analysis and merge the themes and findings.

3.7 Pilot and further pilot studies

The methodological nature of this study is supported by its pilot studies (Liu, 2009) and by the critical view of relevant published museum-based research. Further pilot activities were also conducted to try out and improve techniques, learn about appropriate researcher roles, and decide which and how many participants and interview questions, plus which and how much equipment, to incorporate into the full study.

In the 2008 to 2009 pilot project with the Natural History Museum, I observed ninety-five Key Stage 3 (ages 11–14) students and conducted twenty-seven semi-structured interviews with the students, teachers, and museum educators. All pilot data were analysed in order to judge the relative efficacy of different approaches in this study. The outcome indicated that the best approach would be an experimental design of controlled settings to see whether technology can fully explain students' learning experiences in a museum. It also suggested that a multifaceted setting (including textual displays and object displays) and detailed observation techniques might further improve the quality of such a study. More importantly, the pilot study's findings directed the next study to a more theorised investigation in order to explore the underpinning 'why' behind visitors' modes of behaviour toward technologies, exhibits, and social interaction, and led to the revision of all aspects of the research questions, design method, and data analysis. The practical codification in the pilot study also enhanced the categorisation of the present study. For instance, in evaluating the pilot study, I found that a more structural list of categories or questions and observations might improve the

focus and efficiency.

The inclusion of other exhibits alongside the main device and video data analysis was strongly recommended by and derived from the pilot study results. Hence, the video recording, interviews, and stimulated recall were heavily considered in order to see the individual and social complexities of learning experiences in the museum—personal interest, previous knowledge, motivation, attitude, and social and cultural interaction. These cognitive findings supported a detailed investigation of various interrelated dimensions in the use of hands-on interactive devices as mediators between authentic exhibits and viewers' learning experiences, which was the key argument used to convince the museums to grant permission for video recording.

In the same vein, the in-depth exploratory status of this study is driven by the pilot study and post-pilot studies in early 2010. It is more important to look at the participants' detailed interactions and try to understand their actions rather than settle for a surface comprehension of their behaviours or ask for a satisfaction rating of museum enjoyment. Hence, the decision to focus on a small number of participants' interactions may help in determining which features of a given device and activities improve learning, for which kinds of understanding, and for which kinds of learners. In addition, to bring more depth to the study, I added video recording to assist multimodal analysis instead of systematic observation. Moreover, based on the pre-pilot observations of visitor groups moving through the exhibit, I decided to conduct the study using only groups of two to four visitors. Part of the reason for this was the concern that filming cannot monitor more than two groups of people

simultaneously, but I also found that larger groups tend to split up and re-form in different combinations, yielding the possibility of different simultaneous conversations, which would result in garbled sound on the recording.

Therefore, a pre-visit recommendation offered to the participants encouraged them to try to stay in one group and advised them to spend more time on the main hands-on interactive device. Although one may argue that such encouragement of asking students to focus more on one pacific device may skew the data. Hence, If they found it difficult to engage, however, I suggested that they continue to the other museum exhibits.

The decision to visit the students and teachers a week after their visit was made partly due to the time limitation, which prevented me from interviewing them immediately after their museum visit. The students were both physically exhausted by walking around, familiarising themselves with the environment, and interacting with the devices, and mentally exhausted by the amount of mode interaction, such as reading the text and watching the video and simulations.

In addition to the main pilot study, I conducted two pilot studies in early 2010 with younger participants from primary school. These studies suggested similar results, but to unify the age, the main data for this study draw from the secondary-school-age participants. Still, by evaluating all of the pilot studies, I was able to construct a more refined and efficient research method in light of the overall findings and research experience. As Robson (1993) suggests, pre-practice is crucial to avoid missing questions, to refine the complexity, and most of all, to sustain a comparable pattern of questioning and timing for the

real interviews and the overall structure of the study.

3.8 Ethical considerations

In many papers, there seems to be a misconception and obligation regarding the inclusion of ethical issues merely as a compulsory social-science requirement rather than a principal consideration. Undoubtedly, ethics are an integral part of an educational and social study, as the crucial concerns of trust and morality arise in these projects (Gregory, 2003). As this study is unavoidably measured by the 'human instrument', concerns for the rights, privacy, and welfare of the participants and institutional policy were carefully considered beforehand.

It is the researcher's duty to minimise the risk of harm. Hence, this study abides by a principle of general ethical agreement and guidelines formulated by the British Educational Research Association (BERA, 2004). To that end, a research proposal for this project was reviewed by the University of Oxford Central University Research Ethics Committee, which granted ethics clearance. The primary objective was to fully inform participants prior to their voluntary involvement by using consent forms and information leaflets (see Appendixes I, J and K), especially for the parents of students younger than sixteen. The information leaflet, consent forms, and ethical approval letters were clearly titled ('How does technology improve the learning experience in museums' for the leaflet and 'Technology-enhanced learning in museums: Using multimodal analysis to explore visitors' learning experience' for the remaining materials, see Appendices I, J, and K) to introduce the participants,

especially the schools and parents, to the topic of the study.

The issues of identity and personal privacy in the report, which arose in the transcribed data and observational field notes, were addressed through keeping the data strictly confidential and anonymous. The participants had the freedom to withdraw from the study at any point. Moreover, to answer the schools and parents' concerns regarding young participants' safety, an additional formal procedure, Criminal Records Bureau (CRB) certification, was granted to me after police criminal record checks.

Researchers such as Erickson and Wilson (1982) have discussed their beliefs regarding the importance of the researcher's responsibility to protect his participants from harm during the study. The agreement on the dissemination based on the environment in which it is collected, and how and where such information and data will be displayed, must be discussed prior to the participant's participation. Erickson and Wilson (*Ibid*.) also stressed that researchers should offer their participants total confidentiality for their participation. This procedure should not be codified as an objective legal standard, but it would be a useful step to inform and protect the participant against any negative outcome during the collection and dissemination stages of the research. In my opinion, this stage was very helpful in gaining more confidence, collaboration, and trust from all my participants and the museums.

The ages of the participants must be taken into account, and I made sure that all of the activities were conducted under the full supervision of the teachers. In addition, I debriefed the research subjects to determine whether any participants required assistance or explanation of questions they were

asked during the course of the interviews or observation. It is my goal to maintain the ethical integrity of the study by delivering transparent research design, methods, and findings.

Regarding such transparent action, however, Gregory (2003) warns of the problematic issue of eager voluntary behaviour from participants to please the researcher. There is no fixed answer to resolve the quandary surrounding this issue, but the researcher must be aware of the matter and evaluate the data accordingly. In the end, as Punch (1994) points out, to a large extent, concerns about ethics in research are connected with countless social, cultural, gender, and individual issues. Therefore, looking at Berg's (2004) concern about the subjectivity of ethics, there is no clear-cut answer, but only justified decisions.

For this study, using video filming on young children in museums was an important issue that needed to be incorporated carefully. First, the participants were able to withdraw at any time. Secondly, I must keep the participants' identities confidential in all of my presented representation of the visual data. This is a major constraint, as I had to disguise the children's faces by using digital video editing software to preserve anonymity. Here, a small issue emerged: In using multimodal analysis, it was crucial to demonstrate the participants' gestures and facial expressions to the reader to verify their attitudes and emotions. Third, to insert audio annotations to clarify incidents corresponding to the selected visual clips, I needed to have additional consent from both the participants and parents. These consent issues were resolved by having additional permission from the students and having their parents

sign another consent form.

The issues of subjectivity, authenticity, and ownership were another concern for this study, as video data not only contain actual images but also audio tracks, which create a higher risk of identification than do traditional alphanumeric data. Therefore, clear information was given to all participants and museum workers prior to the filming process. The additional copyright issues concerning identifiable images of materials from the museums, textbooks, or educational tools were discussed with the museum curators and designers, who granted permission. All of these digital video materials are safeguarded with passwords and locked away.

3.9 Problems and limitations

Visiting museums is a mobile process, and following the movements of an excited student who is visiting a museum for the first time was a challenge. First, it was difficult to predict students' spontaneous movements, as they were given instructions to explore the museum freely, finding out what they were engaging with and to whom they were talking. What the video had to record was therefore not solely the students' movements, but also the observed subject and their reaction toward it. This problem was also encountered by Allan (2002), suggesting the difficulty of undertaking a study like this at a highly interactive museum environment, where the challenge is beyond those inherent in most laboratory or school settings.

Secondly, in order to maintain the 'naturalistic' approach, I had to position myself at a sensible distance, allowing the students to respond to the

environment without my obstruction and presence. This, however, meant that I missed out on certain detailed gestures, and sometimes the moment of their interaction. This problem was later resolved by having a separate audio recorder on the participant that corresponded to video observation data.

Third, and also mentioned in Allan's research (*Ibid.*), was the acoustics of the public spaces, which created a huge amount of ambient noise. The background noises included nearby visitors' conversations, the myriad sound effects from the technologies, and even the participants' clothing rubbing against the microphone. Even though the words were audible, the background noise made the participants' spontaneous discourses fragmented, and sometimes ambiguous. As Allan (*Ibid.*, p.264) points out, one important factor is that 'in conversation, speakers seldom articulate what is obvious to listeners: the details of the physical situation they are attending to, the set of common experiences they have shared over the years, the "short-hand" words and phrases they have come to use together.' This is a clear limitation that one researcher cannot overcome in such a short period of time. The only solution was using stimulated recall to reconfirm the findings; however, it was still challenging to capture every detail, and the noise made the recording and transcribing process time consuming. In the end, the noise reduced the accuracy and affected the comprehensiveness of the study.

Yet another issue raised by Allan (*Ibid.*) that occurred in this study was in the interpretation and analysis of the results. There were limitations and problems of other variables, both from the dense and complex museum environments and from the choice of schools, which can influence how the

participants behaved and what they perceived. School variables, for instance, included demographics, previous experiences, personal interests, attitudes, expectations, group dynamics, the type of school, and the students' current state of comfort and energy; any of these could certainly affect the findings. Museum variables included the location of the museum in relation to the school, physical accessibility, lighting, seating, technological difficulty, ambient noise, and crowdedness. These variables might influence the validity of the outcome. I argue, however, that the concise and thorough interview questions and assistance from the stimulated recall improves the study analysis.

3.10 Conclusion

This thesis explores schoolchildren's engagement and learning in museums. In this chapter, the rationales of the research questions, qualitative approach, and diverse research methods, including semi-structured, stimulated-recall, and group interviews, document analysis, and observation, have been clarified. In particular, I argue for the importance of combining stimulated recall with observed video data in order to analyse and validate the students' behaviours and thoughts. The importance and complexity of presenting comprehensive multimodal analysis data in a more ethnographical manner are illuminated. Moreover, some difficulties that happened during the research process and how these problems affected the methodological decision are shared. What I tried to achieve in this chapter is to demonstrate an efficient and grounded engagement with theory and a rigorous methodological approach throughout the research process, which has

generated a comprehensible and valuable contribution toward educational research.

Indeed, given the thorough research methods chosen, it is important to contextualise the studied subject prior to discussing the fieldwork, which leads to the following chapter about the content of the museum exhibits.

Chapter 4: About the Two Museums

4.1 Introduction

Having discussed the chosen methods and paradigms, it is important next to examine and comprehend the chosen contexts to fully understand the rationale of this study. The two institutions selected for this study are the Natural History Museum and the Churchill Museum, both in London. The participants are secondary-school students and teachers who come to these museums on field trips. This chapter justifies the rationale for combining the different types of museums into one empirical study. It begins with detailed functional, geographical, and contextual information about the museums, and then offers a descriptive yet analytic justification based on the similarity of the two museums' approaches. These similarities include the mission statement of the museums, the combination of historical sites with new technological representation, curatorial methods, and the ages of the participants in this study.

4.2 Site One: Natural History Museum, London

Natural history museums have been established worldwide, and are mainly publically funded. The Natural History Museum in London is located in South Kensington, where other renowned museums and public institutions are also situated, such as the London Science Museum, the Victoria and Albert Museum, the Royal Albert Hall, and the Imperial College of London. The close proximity and connectivity of these institutions and buildings makes this area a famous sightseeing location as well as a unified district of history and

knowledge. The Natural History Museum fulfils its educational function in the shadow of its long history, vast collections, and tremendous architecture. Therefore, it is inevitable for many people, especially the schoolchildren in this study, to have a sense of the boundaries of authority and to have a greater sense of an 'academic' expectation prior to their visit.

History and architectural history

The Natural History Museum was opened to the public in 1881, but its founding was actually in 1753 (Natural History Museum, 2010c). The museum's mission is to 'maintain and develop [its] collections, and use them to promote the discovery, understanding, responsible use and enjoyment of the natural world.' By sharing and advancing its knowledge of the natural world, the museum may enable people of all ages, social and cultural backgrounds, and interests to appreciate and be inspired to take 'better care of our planet' (Natural History Museum, 2010a).

This museum houses the largest natural history collection in the world and holds more than seventy million specimens, ranging from microscopic slides to ancient fossils. It is a cultural heritage of natural scientific and geographic education, founded by an eighteenth-century collector, Sir Hans Sloane, whose contributions were continued by many benefactors (Natural History Museum, 2010c).

The museum is a London landmark for its architectural history. The main site was initially designed by Captain Francis Fowke. After Fowke's sudden death in 1862, however, Alfred Waterhouse altered the design of the building, transforming it from Renaissance to German Romanesque in 1865

(*Ibid.*). The main site connects to a new site, the Darwin Centre, which houses a research area called the Cocoon. Opened to the public in 2009, the state-of-the-art Cocoon cost £78 million and houses a vast number of valuable specimen collections, laboratories, and scientists' working environments. The building was designed by C.F. Møller Architects of Denmark with unconventional features: It is an eight-storey, curved, sprayed concrete structure with 3,500 square metres of hand-finished polished plaster (Natural History Museum, 2010b). The bare concrete and white plaster on top of the stone floor and large glass windows allow natural light to come through the building, illuminating the working areas within. These architectural features convey a sense of a clean, minimal, and almost clinical atmosphere. The two buildings present a contrast—traditional and contemporary, old and new—yet the imposing atmosphere of the building as a whole is carried throughout. As visitors generally have to enter the main entrance of the older building in order to reach the Cocoon (see Figure C), this impact is further reinforced.



Figure C: Natural History Museum, London floor map

The Cocoon

The Cocoon continues the collections from the other parts of the museum, including collections covering botany, entomology, mineralogy, palaeontology, and zoology. As well as exhibiting specimens, this site is where most of the museum's hands-on multisensory interactive activities take place. The main subjects of the Cocoon are botany and entomology, so the physical authentic exhibits are mainly plants and insects. For a school visit, the school is normally required to book a session in advance in order to prevent overcrowding. Although the trip is made in collaboration with the museum, the visit is run and structured by the teacher.

One of the main features of the Cocoon is a 'tour' that is virtually guided by wall projections and video. The 'guides' are scientists who work for the museum, and they repeatedly appear throughout the entire space so that

the visitor may gradually become more familiar with them. Most of the displays in this building are animated touch screens, which encourage physical participation as students study nature and scientific discoveries, plan expeditions, and identify species (Natural History Museum, London, 2010b). As one of the Cocoon designers from the Interpretation Department of the Natural History Museum mentioned during an interview:

> We are trying to give a flavour of what's in our collections, specimen-wise. So people can understand the breadth of things that are housed here. We worked with senior-age-group-plus, so it's eleven years and over in mind when we were developing interpretation. So everything is pitched up to that level, and obviously the curriculum links to that. We work closely with learning to ensure that we were covering as many types of learning as possible.

This statement makes it clear that the museum is trying to provide public engagement for all ages and an accessible interpretation platform. In particular, 'as many types of learning as possible' implies all types of exhibited representations and materials currently extant, ranging from text, activities, and technology to staff training. Although public engagement is the main goal of the entire museum, it was particularly important when designing this new section.

Within the Cocoon, beyond the traditional authentic specimens are

high-tech glass cabinets that light by touch, revealing specimens and virtual illustration of herbarium sheets from the seventeenth century, the pages of which can be 'turned'. There are also many glass-walled laboratories, which allow students to observe real scientists at work naming, analysing, and preserving specimens. In certain areas, students are able to speak to the scientists behind the glass by pressing a button and speaking through an intercom. A key part of the visit is the 'Nature Plus' card, a barcoded card that can be scanned at exhibits, saving information for students to access later online.

Although interpretative aids abound, the presence of museum educators is subject to their availability. They normally set up a stall with a range of specimens for students to handle, discuss, and quiz each other about. Some stand next to the interactive technologies with additional microscopes to help students learn more about the techniques used by scientists in their molecular and morphological research.

The museum's objective for the age group that is the focus of the present study (*i.e.*, Key Stage 3–4) is to introduce pupils to the taxonomic research that goes on the museum (Natural History Museum, 2010d). Using the activity provided by the interactive devices, the museum educators, and the botanical and entomological specimens, the museum hopes to encourage students to develop an understanding of and knowledge about variation and classification, as well as scientific skills in identifying, collecting, selecting, and interpreting evidence (*Ibid.*).

Here, the main device is a 'planning your expedition' table, where

visitors must choose the appropriate tools and materials for a virtual expedition. It is comprised of two main screens. The first is the instructional screen, with a video simulation of a scientist asking questions and giving instructions with both sound and subtitles. It responds to the second screen, a table (a sensory projection from the top), where the visitor can digitally 'respond', 'move', 'type', and choose from the given options.

Route of Cocoon visit

A museum is an active and mobile learning environment. As discussed, the ability of the students to roam at will made capturing and analysing processes challenging because it was difficult to predict their reactions to the exhibits. The purpose of this section is, therefore, to briefly illustrate their route through the Cocoon. All of the students, particularly the three chosen groups, had very similar visiting patterns, as they experienced similar locations, museum educators, and activities. This section, with Figure D, provides an illustration of the students' movements through the different types of exhibits. The three chosen groups will be discussed later (see Sections 5.2, 5.3, and 5.4) in detail as part of the interactional highlights.

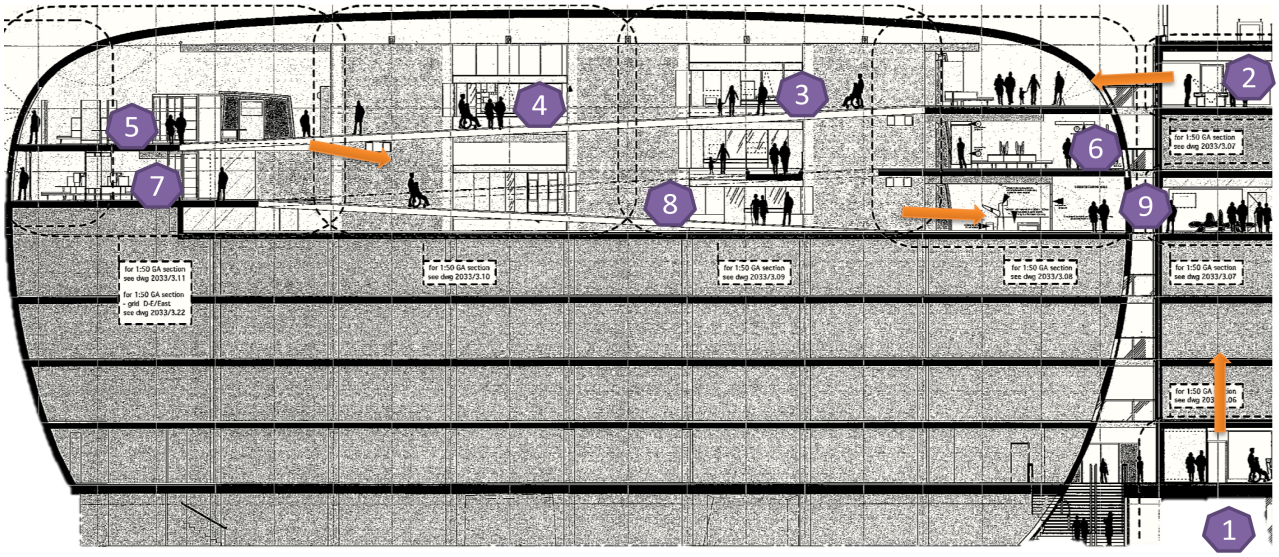


Figure D: Cocoon, Darwin Centre, Natural History Museum, London floor map

① and ②To begin the students' activity in the Cocoon, a student group of five and one of their teachers start from the seventh floor. Four identical touchscreen interactive devices introduce the types and numbers of botanical and entomological specimens the museum contains. These devices are displayed as desktop interfaces that are joined up with glass cabinets where real specimens are located. The students are able to scan their Nature Plus cards next to the interface if they want to take the information away with them. Walking along this device, one encounters a life-size 'welcome' projection and an interactive screen presented by virtual scientists. The interactive screen provides the 'touch' feature—touching the object on the table triggers a response from the front screen.

③ This is a space comprising two interactive devices: One is a projection sensor on the topic of biodiversity, and the other is a touchscreen on categorising insects. This section is designed to teach the relationships between organisms.

④ This is a digital touchscreen collection of seventeenth-century herbarium sheets.

⑤ Research on malaria is a key mission of the museum. This section focuses on how mosquitos spread the malaria parasite and how DNA sequencing can identify the species, allowing scientists to control mosquitoes and slow the disease's spread. There are two main devices: a touchscreen interactive game based on this topic, and a touch-object sensor like that in ②, which introduces the types of tools scientists use to capture mosquitos. There are also models of mosquitos and some basic textual displays on the mosquito's life cycle, fighting malaria, and one of the functions of DNA sequencing. In addition, this part of the building is adjacent to a real laboratory, and students can see how scientists work with the specimens.

⑥ The main multimodal technology, which allows visitors to 'plan an expedition', is located here. As field sample collection is a crucial part of the museum scientist's work, the exhibits and devices here are devoted to methods and tools for collecting insects on a field trip. There are four identical devices with two types of 'planning your expedition' games, which are based

on real museum expeditions. Each device is structured like a table, where visitors can choose suitable tools and documents for a virtual expedition. It consists of two screens: One is an instructional television screen showing a video of a scientist asking questions and giving guidelines, with both sound and subtitles; the other responds to the television screen, a sensory projection from the top table where visitors can digitally ‘touch’, ‘move’, ‘type’ and choose among the given options. In addition, the device has a barcode scanning function for the Nature Plus card, which they can scan to record certain factual information about their virtual expedition, such as the function of a tool or basic information about a location. The detailed function and design of this device are also further discussed in the scenarios (see Sections 5.2, 5.3, and 5.4). Also on display are authentic tools and equipment, alongside some textual displays that explain the function of these items.

⑦ This is another interactive sensory device, which provides a simple insect-matching game. It is designed to show students how to examine specimens through a powerful microscope. This room is connected to another part of the laboratory to allow the students to see scientists in action.

⑧ This is a room where a real scientist explains the process of preserving specimens. Students are encouraged to ask question through the microphone. If the scientist is absent, a looped video in the next room explains how to preserve beetles.

⑨ The last touchscreen stands are located in this room. They allow students to type in any questions or comments that they would like to share with the museum. The typed statement or question automatically appears on the front screens. This is also the exit of the Cocoon.

Along this route, the students were told to freely explore at their own pace without any prior instruction. The architectural layout of the building meant that all of the students would have to walk through the devices in this particular order. The nine locations mentioned were where most of the interactions occurred, although the predominant action generally happened at ⑥, the 'planning your expedition' device. During their visit, most of the students naturally formed into groups of three or four.

4.3 Site Two: Churchill Museum and the Cabinet War Rooms, London

Like the Natural History Museum, the history, architecture, and location of the Churchill Museum emphasise its importance and value. This museum is one of the Imperial War Museum branches, and is located in London, ten feet below the Cabinet War Rooms in a preserved historical site across from the Houses of Parliament in Westminster. The geographic location of the museum has strong political and royal connections with its surroundings, such as Number 10 Downing Street, Buckingham Palace, Westminster Abbey, and New Scotland Yard, and is situated to a neighbourhood of magnificent architecture, including the Tate Britain Gallery. This combination provides a great sense of national and cultural identity, and visitors cannot help but think

of British history when they walk around the museum. In many cases, school students visit the museum as well as another nearby attraction.

History and architectural history

The Churchill Museum is also known as the Cabinet War Rooms. It is a biographical museum, unveiled to the public in April 2003 and dedicated to Sir Winston Churchill. Much like the Natural History Museum, a major part of the mission of this museum is to provide various learning opportunities and help visitors engage with its resources. As one of the main curators stated:

> Because it is *the* Churchill Museum. We felt that we have to give you [the visitor] as much detail about the story as possible, but at the same time, you don't want to bore people. In fact, if there is anything you want to do, it is to engage them.

The curator indicated that the difficulty of delivering textual information about Churchill was understood by the museum's designers. As he further emphasised:

> [The museum] is meant to entertain, entice, involve, engage…all those words…and all of the electronics are designed to do those things. For instance, you want to present Churchill's speeches, which is a great way to understand the man, but keeping people listening and reading in a museum is difficult, so the mixture of objects and technology, the different style and approach, is to

basically design to engage.

The curator then explained how the museum space is divided into two sections: the Cabinet War Rooms and the digital room (the latter term is used to distinguish the two in this study). The essential part of the Cabinet War Rooms was used to house a British government command centre during air raids in the Second World War. The rooms and displays are preserved in their original condition, and wax figures are used to imitate the original working environment, including the cabinet office, the map room, and even Churchill's bedroom (Churchill Museum London, 2011). Both the Cabinet War Rooms and the digital room are located underneath the Treasury building. The museum preserves its wartime, almost claustrophobic, atmosphere due to the original basement setting, which prevents any natural lighting and is equipped with soundproofing and ventilation (Holmes, 2009, p.15) in addition to maze-like tunnel corridors. The original architecture and the location also provide a sense of the 'real' for visitors.

In contrast is the second part of the space, the digital room, which houses numerous hands-on digital devices, authentic artefacts in glass cabinets, and textual displays that interpret the historical documentation of Churchill's life, achievements, and the war. The room is divided into five sections chronicling periods of Churchill's ninety-year life. It is not laid out in chronological order, however, but rather in a thematic curatorial style. It begins with the high point of Churchill's career, his appointment as Prime Minister and war leader in 1940, followed by his subsequent career, including

Cold War statesmanship and his second term as Prime Minister, which concludes with moving footage of his funeral. The tour continues with his early life, his political career as a maverick politician, and returns to 1940 with the original 10 Downing Street door at the end of the exhibition (see Figure E).

The main technology

The main chosen multimodal technology in the centre of the exhibition room is the Lifeline. This is a fifteen-meter multi-sensory and multi-user touch-sensitive table formatted as a series of chronologically arranged folder files from each year, month, and even day of Churchill's life and times. When visitors touch the interactive strip at the edge of the Lifeline, files open up to different contextual data, films, photographs, and soundtracks, offering documents ranging from a school report to a letter to his wife. As in many video games, there is a 'reward system', which is a five-second simulation throughout the entire table if the user triggers a specific date; for example, if a user selects Churchill's birthday (30th November), a series of birthday candles appears. These special effects provide sound as well as visual simulation in order to provoke visitors to further explore the dates and to encourage social interaction among the users. The museum's curator described the aim of this particular device:

> The whole concept of the Lifeline table is to learn from the people around you…In ten years' time, the technology or animation may not be intuitive anymore. But people can still learn by looking at how other people use it. It is like if you are on

> a train, the temptation is always to look over your neighbour's shoulder. Or the fact that you can learn by talking to the neighbouring visitor.

In stating that social interaction is the main objective, the curator suggested the importance of group interaction, physical imitation, and conversation. He noted that constant use of the latest technology may not be the ultimate solution for museums, nor the way to truly understand how people learn and behave. Therefore, when the Churchill Museum was being designed, especially this particular section, the designers intended to address this concern. In a way, the digital devices were designed to encourage visitors to be researchers themselves, seeking out what interested them.

Museum activity

The museum activity for this study is an existing student programme designed by the museum educators for Key Stage 3 students. The session begins with forty minutes spent visiting the War Rooms, ten minutes in an idea-gathering workshop in the museum learning centre, twenty minutes at the exhibition space with all the technologies, and a final ten minutes writing up ideas and giving presentations in the learning centre again. In some cases, with large numbers of students, the museum educators have one group of students in the main routine while another group starts with the workshop. During the forty-minute visit, the students are usually given a handheld audio guide, a personal mobile phone-like device that permits users to access information by dialling label numbers. This allows them to walk around the

War Rooms freely and hear a short explanation of the function and history of the rooms.

The workshop that follows is a two-part activity. The first part is the ten-minute idea-gathering session in the learning centre. During the study, students are asked to gather ideas and write on a whiteboard table their thoughts about the characteristics they consider to comprise good leadership. From these ideas, they then have to choose two leadership characteristics and, by using the museum resources from the exhibition room, they have to find evidence that supports or contradicts their chosen characteristics—hence the twenty minutes spent in the museum exhibition space as part of the research quest. For example, during these twenty minutes, if the group decides to have 'persuasive' as their chosen characteristic, they have to find relevant material from the museum that will either support or contradict the idea that Churchill was a persuasive figure. To conduct this research, each group of students is given a clipboard, paper, pencil, and a digital camera. The museum is generally text-oriented, but the students can either gather written material or take pictures of artefacts to support their findings.

The second part of the activity is another ten minutes spent writing up ideas and giving presentations in the learning centre. Based on what the students found in the museum, such as quotations, factual information, or photographs taken with their digital camera, they are asked to make a poster or a presentation about their findings.

The museum activity aims to offer the students different perspectives about Churchill in an unbiased representation. It focuses mainly on Key Stage

3 because these students' curriculum addresses the British and international experience during the Second World War. In contrast to the Natural History Museum, which sometimes lacks museum educators, the presence of museum educators is crucial at the Churchill Museum during the workshop activity. Their role is to be more of an expert and offer guidance for all visitors, including teachers. They provide students with questions and guide them to find resources that they need for their quest. The teachers, again in contrast to the Natural History Museum, have a less prominent teaching role at the Churchill Museum; instead, they serve in a supportive capacity during the students' visit.

Route of museum visit

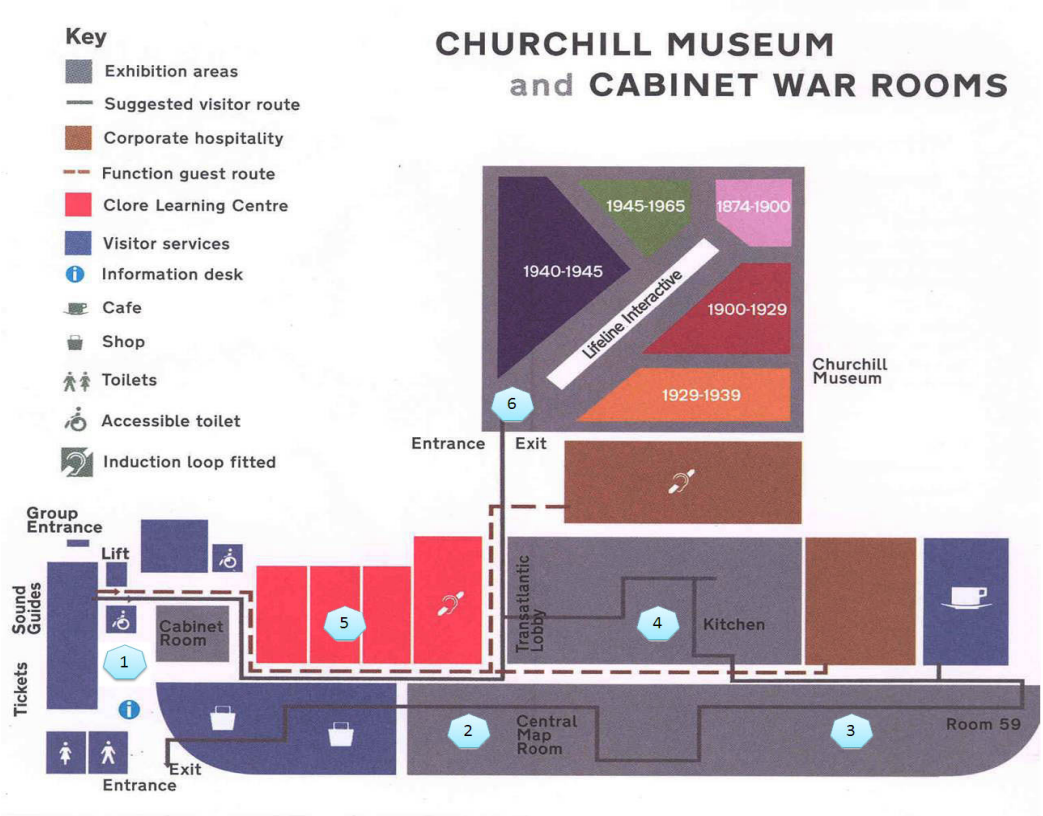


Figure E: Churchill Museum floor map

①This is the entrance. Students descend one level to the basement, where they receive a handheld audio device for touring the Cabinet War Rooms.

② This is the beginning part of the War Cabinet Room, which was last used in March 1945. This is where Churchill would hold his meetings, and includes maps and phones. The students normally stop at this site with their audio devices, which explain the function of this particular room with siren noises in the background to accentuate the moment in history.

③ and ④ Here are a series of rooms, including Churchill's bedroom, the kitchen, Churchill's office, and, most importantly, the central map room. This room remains precisely as it was on 16th August 1945. The walls are covered with wartime maps, including the Convoy Map, which is dotted with thousands of tiny pinholes plotting the progress of Allied ships (Churchill Museum London, 2011). There are many authentic artefacts here, such as colour-coded telephones, piles of books and documents left behind, and even the rationed sugar cubes found in an envelope belonging to Wing Commander John Heagarty (*Ibid.*). This, like ②, is a popular spot where students normally stop and listen to the audio device.

⑤ This is the activity room, where most of the posters are made and group discussions happen. This room includes a smart white board to provide photographic slideshows of Churchill's life, white board tables for students to write down their ideas during the activity, and digital cameras and a printer for

students to take photographs of the museum and print them out. Students generally spend twenty minutes of the activity time in this room before moving to the digital room.

⑥ This is the digital room, where the second half of the activity takes place. The room is separated by many large panels, which categorise Churchill's life into different topics, such as his career, his personal interests, and his death. Each panel is illustrated with one famous quotation from Churchill and an image to accompany it. Between each panel, there are numerous physical objects and digital screens. This is also where the Lifeline is located. The long digital screen is the main light source of the room. Surrounding this main device, there are many authentic artefacts, such as Churchill's jacket, handwritten letters, and wartime equipment such as gas masks. All students encounter the Lifeline as well as other hands-on digital devices during their visit before they return to ⑤ for their final debriefing.

4.4 Conclusion: Combining the two museums into one empirical study

This study was undertaken in collaboration with the Natural History Museum and the Churchill Museum as one empirical study. It was designed to answer the question of how multimodal technologies enable schoolchildren to learn more effectively in museums. The decision to combine the two museums into one study was based on several reasons. First, both institutions recently made large investments in developing state-of-the-art technologies, which provided an updated perspective on the technologies

available today. Both were set in renowned and respectable geographical locations with other famous attractions nearby, and in architecturally significant buildings. The two museums intended to improve the accessibility of their resources by introducing multimodal technologies in a separate section, keeping the technologies apart from many of the authentic artefacts. This accentuates the sense of old and new, which can be seen as a separation as well as a combination.

Secondly, because the two museums offer exhibits in different subject areas, the data can show how different modes work across discrete subject matters and with a variety of visitors. Although the multimodal technologies in the two museums had different appearances and functions, and were dedicated to different subjects, they had similar design features, such as interactive touch sensors, sound effects, video, and digital texts. The museums had similar missions of encouraging visitors to appreciate and understand the exhibits in a wider context and to interpret them like a researcher. Each museum has a long-established learning department, which provides many educational programmes, activities, and educators to suit all ages. For this particular study, both museums had an activity for Key Stage 3 and 4 students that allowed them to experience authentic objects, exhibits, and the architecture of the museum as well as the multimodal technologies. In addition, although the activity was taught informally, it had some compatibility with this particular age group's school curriculum and helped to develop their personal interests.

The concept of public engagement for learning was crucial in designing

both museums. Therefore, bringing the two museums together in one study allowed me to explore in depth the differences, similarities, and connexions in what *engagement* and *learning* are taken to mean in those museums, and how multimodal technologies are used in order to realise the museums' goals. Although the different context and subjects of the two museums may have resulted in differing datasets, the intention of this study is to explore students' interactions in relation to their experience and perception of engagement and learning in a museum context, which will be discussed in the following chapters.

Chapter 5: Findings: Natural History Museum, London, Part A

Structure and presentation of the chapter

This chapter should be seen as one continuous discussion with Chapter 5, Part B. Since the cumulative detail and quantity of the analysis may exhaust the reader, however, the data from the two museums are divided into four separate sections, two covering the Natural History Museum, London (Chapter 5, Parts A and B), and two covering the Churchill Museum (Chapter 6, Parts A and B). Nevertheless, as previously mentioned, the two museums are considered as one empirical study. A total of six groups of students (Groups A through F) were observed in six different scenarios, three at each museum; Groups A through C will be considered here. In addition, the names that are used in the presentation of the findings are not the students' real names.

A photograph with a brief account of a scenario of each group is used to sketch out the architectural and spatial relationship between the students, the device, and their environment (see Section 3.6). This layer is then compared to multimodal data derived from the video, the interview transcripts, and the visual documents provided by the students. The multimodal data were transcribed into dialogues of punctuated written form, with some references made to body movements, gestures, and facial expressions. Additional photographic documentation was used to enhance some of the visual interpretation. In the same vein as the audio recordings, the utterances were transcribed as accurately as possible. Certain unfinished utterances were written to match the participants' intentions whilst making the transcription as

clear as possible. The repetitions of words or instances where students shifted focus in mid-utterance or did not complete phrases were marked by '(.)'. A long pause during an utterance is symbolised as '…'. In order to better illustrate the description of the students' actions, photographs were attached to correspond to particular moments.

5.1 Introduction to Part A

This chapter serves to answer the first operational research question:

In what ways are school students engaged by technology-driven multimodal exhibits in museums?

The data used to answer this question are derived from video data, field notes of the students' interaction, and semi-structured interviews conducted with the schoolteachers and museum educators. This chapter sketches an overall picture of the students' physical and social interactions with the multiple modes presented at the Cocoon from observer's, schoolteachers', and museum educators' perspectives. By describing and analysing these interactions, this chapter outlines the interconnected relationship between the students, the museum activity, the multimodal technologies, and the students' social interactions. It lays the foundation for later chapters (Chapter 5, Part B, and Chapter 7), which will further describe the ways in which these interactions allude to the students' interpretation of the learning experience—

which, in turn, hints at ways in which museums might be reconfigured to maximise learning.

Due to the complexity of the social, cultural, and individual differences among students and the countless variables presented by a museum (such as the design of the technology interfaces, the type of museum, or the activities offered), the data here are not presented in order to draw broad generalisations about museum-based learning, but rather to illustrate holistically and specifically how certain features, devices, and materials influence students' actions.

Chapter 4 outlined a detailed contextual backdrop, including historical, geographical and functional information about the Natural History Museum. The findings from this museum show an important interrelation amongst the multimodal technologies, museum activity, physical authentic exhibits, museum educators, and combination of modes. Multimodal analysis offers a detailed picture of the interactions in each student group, which sheds light on a number of emerging themes on students' meaning-making processes: how architectural arrangement affects their physical behaviour, how they work in groups, and how discussion through face-to-face conversation influences their learning. These are supportive evidence to be further explored in Chapters 5, Part B.

Group A consisted of three students, Chris, Steve, and Amy. Section 5.2 focuses on their interaction with the 'planning your expedition' device (labelled as ⑥). Group B consisted of two students, Emily and Charlotte. Section 5.3 analyses their interaction with the museum educators and the

authentic specimens. Group C consisted of four students, Alex, and Nathan with periodic interruption by their classmates Roger and Tom and their schoolteacher Beth. Section 5.4 considers their interactions with the exhibition as a whole, as it is important to explore how they interpret the content of the device in relation to the rest of their museum visiting experiences. The three chosen groups of students had never been to the Cocoon before. Some of them had previously visited the Natural History Museum when they were five or six years old. Prior to their visit, they were told to spend a slightly longer time with the chosen hands-on device for the purpose of this study. These three groups came from different schools outside London. Although the differences in their schools might have affected the ways they behaved and understood the material, that is not the main concern of the research question, and it is not discussed further in this study.

5.2 Group A

Interaction with 'planning your expedition' device



Figure F: Photograph of 'planning your expedition' multimodal technologies, Natural History Museum, London ® Ariel Liu

This section describes the spatial interaction among the three students in Group A. Although the observed behaviour and responses here cannot be generalized to every group of students, this particular case reflects many other students' interactions in this space. A photograph and a narrative account summarise the museum educators', schoolteachers', and students' perspectives, and fits into my theoretically informed interpretation. It reports the comprehensive interaction, but also shows the 'how' and the 'why' behind the students' reactions to the sensory device.

The discussion in this section focuses on detailed features and the spatial relationship between the students and the ‘planning your expedition’ device. The photograph (Figure F) illustrates the interface of the device. There are four identical projection-based desktops adjacent to one another in the centre of the room. Each device contains two ‘planning your expedition’ games, designed as if the user is a scientist who is told to pack for a field expedition. The chosen locations and themes of the expeditions are based on real trips made by the museum scientists. The feature actions for the users comprise taking a real photograph for an identity card, choosing tools to capture specimens, reading permission letters, and answering phone calls from the museum project leader (see Section 4.2). Surrounding the devices are authentic tools that scientists have used during expeditions and some textual information on the panel walls. The tools also appear virtually in the games. The four devices are partitioned by two life-sized panels, which display images of scientists and textual information related to their experiences on expeditions. Each device consists of two main screens: One is an eye-level front screen that instructs the user on how to play the game, and the other is a projection from above onto a table surface. The screens respond to each other—for example, touching the table surface triggers the front screen. The device platform is also low enough to enable students to see other users’ interactions with the other devices. Due to the lack of windows, the room appears to have a cinematic effect, with some soft and dim spotlights on the textual information panels.

Due to the dimness of the surroundings, as seen in Figure F, the light from the screens immediately drew the students' full attention. They instantly recognised that the front screen, showing a scientist offering auditory and subtitled information, provided instructions for the game. The large table could physically accommodate four or five students for group interaction, although the device only responds to one user at a time. The students' content expressions and relaxed postures suggest that they were fairly comfortable in the environment. This photograph was taken after they played one game as a group; all of them decided to play another game on their own, yet they still socially interacted during the second game, asking each other about their decisions.

Scenario

Chris and Steve entered the room first, with Amy trailing a few steps behind them. The space was already packed with students from other schools, but after a few moments, a spot in front of the device opened up, and the boys seized the opportunity to take a turn. Amy saw them and approached to join the group. She stood to one side of the instruction screen while Steve took the other side and Chris secured a place in the middle. As they quickly learned, the device could only accept one command at a time, and since Chris was most conveniently positioned, the others allowed him to take charge of the navigation of the game.

The first part of the game was to take a picture of the user's face so the device could generate a virtual identity card. The group was surprised at this feature—Amy, for instance, exclaimed, 'It's taking a picture of you!' as she

noticed Chris's face appear. Once the photograph was taken, the next step was to drag the card into the user's 'bag'. Amy assumed a tap would suffice—she advised the others to 'just tap it'—but when that failed, she realised that the device had a 'drag' system instead, and corrected herself with an excited, 'Oh, you drag it! Oh my God!'

Chris seemed impressed and smiled as he dragged his card into the bag, announcing that it was 'so cool'. Steve agreed, and grinned as he helped Chris put his card in the correct place.

Throughout the game, the group spent a great amount of time staring at the front screen's subtitles, as the ambient noise from the crowded room made it difficult to hear the instructor's voice. One of the instructions they were given was to remove virtual flies from a net. The instructor gave them the choice of using a pocket pooter or a mechanical pooter. (A pooter is a device used to collect insects.) At first, Chris reached out to select the mechanical pooter, but before he could do so, Steve stopped him with a touch and pointed to the pocket model, joking, 'It sounds better—she might want to keep it in her pocket all the time, in case she finds [a fly] while she is on the toilet or something.'

Chris replied, 'No, this one'—the mechanical pooter—'is just as big,' and added, 'You want to put it in the bag?'

Meanwhile, as Amy was trying to help Chris resolve the technical difficulties of dragging items on the screen, she triggered another instruction from the front screen, then said, 'Oh look, they look so wide, we don't want a long [pooter].'

In the end, Chris selected the mechanical pooter, as this was the only image that reacted to his touch, and Amy and Steve frowned; Amy added a quiet, ‘Oh, no’ for good measure.

In the next part of the game, the instructor asked the group how they should store delicate specimens and transfer them safely. Two images appeared on the screen: a pair of blue gloves with a Ziploc bag, and entomology forceps with a pin. Chris and Amy pointed to the gloves, and Chris exclaimed, ‘We need, like, a box or something!’

‘And foam,’ said Amy.

‘Well,’ Chris replied as he read the screen, ‘forceps with pins.’

‘Bags,’ Amy added, looking at Chris, ‘we need both.’

‘I don’t know,’ Steve murmured, and glanced at Chris and the screen. ‘Where do you stick the pins?’

Chris immediately pointed to the previous exhibition room and replied, ‘In those boxes, you know, like earlier on, like the mosquitoes!’

‘No’, said Steve, ‘no, they are only small flies.’ He paused and dragged the forceps and pin into the bag. ‘You only do that with little animals. They are little animals.’

Amy stroked her hair, indicating she was ignoring the disagreement, and Chris gazed at the front screen in order to continue the game.

Multimodal data

Time	Participant	Facial Expression, Gesture, & Body Movement	Language & Sound	Interactive Device Response	Image from the Device
03:17	Chris, Steve, and Amy	A and C point at the gloves on the projection screen. S stares at the projection screen but talks toward C. C then points upward to suggest the previous exhibit. S pauses, then drag the forceps pin into the bag immediately. A strokes her hair to ignore the disagreement. C just gazes at the front screen.	C: We need, like, a box or something. A: And a foam. C: Well...forceps with pins. A: Bags...we need both. S: I don't know...where do you stick the pins? C: In those boxes, you know, like earlier on, like, the mosquitos [the previous device]. S: No, no...there are only flies, you only do that with little animals...they are little animals.	Instructor asks, 'How will you store a delicate specimen and how will you transfer the specimen back safely?' Two images appear on the projection table: a blue pair of gloves with a Ziploc bag and entomology forceps with a pin.	
03:59	Chris, Steve, and Amy	A immediately shouts and points at the Outdoor Centre letter. Both C and S take their time to read. S reads the letter out loud quickly. A waits for C to make the final decision. C drags the outdoor centre paper into the bag at the end.	A: Outdoor. S: Hi there, yes, we do have accommodation for you and your colleagues for the Dipterists' Forum...bring this letter as confirmation. C: This makes it cheaper, though...cause it can't be too expensive, cause they don't get much money, do you? S: Yeah...they pay for it! [looks at the researcher] They would pay for it...it's an all-paid trip. A: No room...so you have to use the mat and the bedding, so I want the lab in the gym. C: Go on. S: Yeah, yeah.	Instructor asks which accommodation the user wants, the Piper Guesthouse or the Outdoor Centre Gym. Two images appears on the projection table, a letter regarding the guesthouse and a welcome letter from the Outdoor Centre. When C selects the Outdoor Centre, the instructor gives advice on the cost and the availability of the room. C then selects the Guesthouse to hear more about that option.	

Table 2: Sample of multimodal transcript for Group A

The multimodal data (Table 2, see Appendix A for full transcript) for this scenario were derived from the three students' interaction, and show a gradual increase in their bodily movements, such as pointing and dragging, in correlation to their increased verbal utterances. Their nonverbal social interaction is a combination of physical modes, such as 'touch to trigger the other screen', 'drag the virtual image', 'listen to the virtual instructor', and 'watch the simulation after they trigger a certain action'. These modes of action provoke the students to be more physically active toward the device and the surrounding space. It is not simply the 'touch' that makes them more receptive, however, as their responses—such as Amy's exclamation when she realised that she could 'drag' an object into a bag—reveal. The 'packing'

experience was also appreciated by Chris, as he commented, 'It's cool!' on discovering the feature.

There was also increased participation between the students and the device, such as posing for a photograph, deciding which item to take, packing virtual objects into a virtual bag, or even scanning the Nature Plus card. These actions made the students more at ease—the device, unlike other items in the museum, was not so fragile that it could not be touched and enjoyed. The students' relaxation was apparent, as seen when Steve began to make a joke about one of the pooters. The virtual space made the students experimental with their decisions, and also made them less afraid to touch the objects, experiment, and possibly make mistakes.

This physical interaction, which triggered vocal interaction and discussion, made the students work as a group. Most of their utterances contained plural nouns—'we' and 'us', not 'I' and 'me'. Even if only one user could navigate the device, the students tried to make group decisions. Indeed, it is this one-user interface that encourages an individual to express his opinion and talk more generally so as to reinforce group collaboration. As Heath *et al.* (2005) suggest, visual clarification and 'touch' interaction provide better group observation and interaction. This is true in this case—for instance, Amy tried to sort out technical issues for Chris, while Steve tried to negotiate with Chris about alternative options. Their dialogue also led to further discussion, and sometimes disagreement, as seen in Chris and Steve's debate over choosing the pin and forceps or the gloves and Ziploc bag for transporting flies.

The students underwent a period of trial and error as they learned how to interact with the sensory objects, and there were some technical problems during their interactions. Still, these 'problem solving' and collaboration activities provided social interaction and conversation among them. They were able to communicate more with each other, express their opinions, and offer help; for example, Amy tried to give more direct advice and reached out to help Chris 'drag' an object (and in the process, she experienced the device for herself). Again, as Heath *et al.* (2005, p.98) mention, co-participation is an experience in itself.

The benefits of co-operating a device in terms of increasing interaction are only applicable if there is enough space and time for the students to work together, however. As the group's teacher, Sharon, observed:

> So there was a junior school in front of us and I found them quite distracting. Certainly, a lot of my students were not prepared to wait, and so they turned. If they got to some of the interactive sites and saw a lot of these little kids with them, they just skipped it and moved on. So, except the three that you were with, the rest of them went through the Cocoon experience pretty quickly, didn't actually stop and engage with each other. I think they need to have it alone to themselves. So the result is different. But once they stopped, looked at it, and took the trouble to get through it, I think they really enjoyed it.

The space was indeed crowded, but the observed group was fortunate enough to use the device and learn from the Cocoon. Later, these three students seemed to bond, and they were able to spend more time with and better discuss the surrounding exhibits, such as the exhibit of tools that scientists use during their expeditions. Chris took his smart phone out and took a picture of one of the exhibits, as he found it interesting enough to document.

5.3 Group B

Interaction with museum educator and authentic specimens

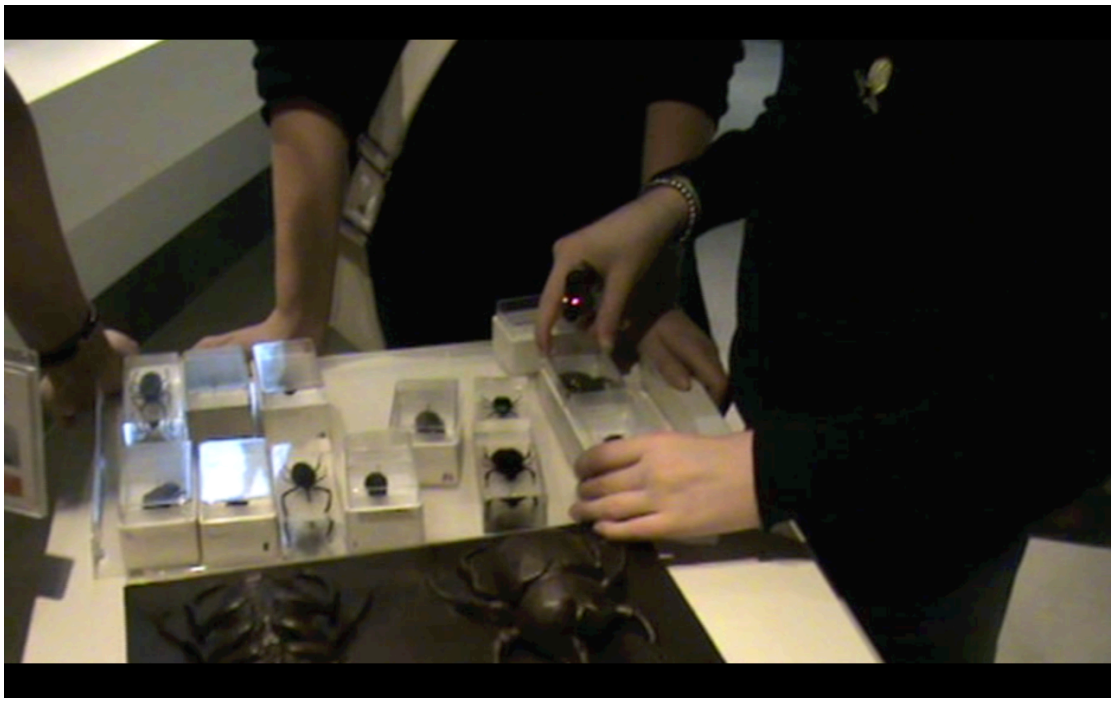


Figure G: Photograph of interaction with authentic exhibits with museum educator, Natural History Museum, London ® Ariel Liu

Figure G shows an intimate spatial relationship between the two students, the museum educator, and the authentic specimens in the stall that the museum educator set up. This photograph shows many species of beetle, either individually mounted on a piece of white foam board in a paper box with a transparent cover, or embedded in a glasslike resin. The rationale behind this type of exhibit is to preserve the fragile specimens while allowing them to be touched and observed. Next to these beetles are two larger replicas cast in bronze, which allow the visitor to physically feel the different parts of the beetle and to more clearly visualise the specimen. This 'beetle stall' is located right next to ③, where two interactive touchscreens on categorising insects are located. The intention here is to bridge the connection between the digital information and the physical exhibits. The activity provided by the museum educator here was to ask students to categorise all of the boxed beetles into four groups.

Much like the space shown in Figure F, the lighting in this space is somewhat dim to improve the visibility of the screens. Generally, the students' attention would initially be drawn by the screen, but the face-to-face availability, eye contact from the museum educator, and the real specimens also attracted much of their curiosity. Due to the limited space of the stall, however, only four people could participate at one time.

The photograph shows the two students in Group B participating in the categorising activity. One student began by matching two boxes together, while the other one watched and gave vocal advice. Again, the relaxed posture of one student, who leaned both of her hands on the table, showed

that she was comfortable in this environment. Her presence at the edge of the station with another student and the specimens signified anticipation of her own physical participation in the activity. Indeed, immediately after this photograph was taken, the other girl began her turn.

The educator was not static. She stood near the stall or by the sensory screens, pointing out the relationship between the physical specimens and the textual and image-based resources. She was also very lively in asking questions and handing the specimens to the students for observation. The majority of the students were fairly shy to begin with, but once they touched the specimens, they began to ask questions and had more vocal interaction amongst themselves as well as with the educator.

Scenario

The scenario below is an extract from a roughly eight-minute interaction. This scenario summarises the general core of the conversation and interaction at the beetle stall.

Emily and Charlotte had just finished reading and touching the screen devices with another museum educator, who explained about different types of scorpions. The two students slowly wandered towards the beetle stall, where museum educator Jill was reorganising boxes of specimens and preparing the stall for the next group of students. As the two stopped in front of the stall, they looked at Jill and started reaching toward the specimen boxes, knowing that the previous group of students had an activity with them. Emily began, ‘Oh, nice colour,’ pointing out the most colourful beetle to Charlotte, then added, ‘I like that one.’

Jill quickly cleared her throat and said, ‘Yeah, I was just thinking about the possibility of selling the pretty ones in the shop. But then I thought they *are*’—she paused and corrected herself—‘*were* living animals. Probably wouldn't be really tasteful.’

The two students smiled as Jill made the joke. Jill laughed, then looked down at the box that Emily was pointing at and said, ‘Now, that’s a chafer. Now, the activity is to try and put these beetles in the four groups.’

Emily swiftly replied, ‘Like the one we did over there!’ Charlotte agreed at the same time.

Jill calmly answered, ‘Yep. So you’ve had practice now. Now, I have got a group ranging from one to four in here.’

Instantly, with Jill’s permission, Charlotte picked up a box, then said, ‘That’s the water one!’

‘Is it?’ Emily questioned.

Charlotte confidently pointed at the previous installation and said, ‘It's the one over there.’

‘Yes, and it goes with that one. Do you think?’ Emily said while pointing at a brown beetle.

Charlotte explained, ‘’Cause that one has got legs.’

‘No, they have got legs, but that one’s leg is just underneath,’ Emily argued back.

As debate continued between the two, Jill rapidly pushed the box toward another corner and said to them both, ‘So, let's just stick this at the corner, then, so you can find any other you think that might go with it.’

Both students carried on. Emily murmured as she picked up another box and looked at it, then turned toward Charlotte's choice and said, 'That one, that one hasn't got very long ones.'

Charlotte hesitated, then said, 'That one,' realising that maybe Emily had been right in the first place.

During the silence, Jill inserted a vital hint: 'Remember, sometimes bits get broken.' She wanted the two to realise that not every preserved specimen is in perfect condition.

After a while, the students completed the activity, but Emily counted their groups and, turning to Charlotte, said, 'One, two, three, four, and five. We have got five groups, Charlotte!' She realised they should have four groups as she spoke.

Jill responded, 'I know, so something is…'

Charlotte quickly moved two boxes to another corner, saying, 'So these two go.'

Emily repeated, 'So you are only allowed to have four groups,' noticing that there were still five groups in the stall.

Jill stated quietly with a grin on her face, 'There are only four groups. This is why it's so hard to be a scientist, to actually classify.'

Finally, the two students came to their conclusion and sorted the boxes into four groups. They both looked up to Jill as she said, 'Okay, right. So, why did you put these together?' The two stayed silent and looked at each other, and so Jill slowly picked up a box: 'Yeah. Okay, in that case, that one is the diving beetle with the streamlined body.' She pointed at another box and said,

‘And this shows you how hard it is to classify things. This is the only one.’ She then looked to the two students and said, ‘Now, let’s put that one in the right group, and that one into the right group. Now, in this little group, you have got what?’

‘Beetles with the legs!’ Charlotte shouted out, as Emily shouted, ‘The longhorn!’

Their excitement made Jill laugh, and then she pointed at the plastic replica beetle on the side. ‘That’s right. These are the longhorn beetles and long antennae.’ She then picked up and pointed to another box. ‘Right, this group you said was various things, like a long whatever…’ She paused to wait for the two to respond again.

‘Long elbow joint, apparently,’ Charlotte answered while animating the shape with her elbow. She knew the ‘elbow’ remark was her idea, and so it was her responsibility to take over Jill’s question.

‘Yeah, it’s got the long snout,’ Jill replied while pointing at a specific part of the box.

Emily quickly tried to draw Jill’s attention by raising her arms to animate her explanation: ‘And then the two long things coming out of it.’

‘That’s right. And that’s called an orchid beetle. And a lot of them have got their antennae like this. Did you know why?’ Jill asked while putting her finger on the bronze casting beetle model. Her action provoked Emily and Charlotte to touch the model.

Emily answered firmly, ‘No,’ which made Charlotte giggle.

While still pointing at the model to encourage the students to touch it, Jill replied, ‘The reason is, the females bore into plants. And then they turn themselves around and they stick their egg tube into the plants.’ During her explanation, both students kept their hands on the surface of the replicas. Jill then picked up a box and said, ‘Lay their eggs, then develop their eggs into larvae, then into pupa, larvae are placed into the plant. Now to make that hole, she has to have that long antennae get in the way, so we have got these antennae right up by the head. Their joint just folds right by the head.’

Toward the end of the activity, Jill said, ‘Now, that one is slightly different. Let’s look at this group for a minute. This one is a weevil. It lives in the Namib Desert and you can hardly see very much of a snout. So they are what we call a very diverse group.’

The two students simultaneously laughed and replied, ‘Oh!’

Jill followed. Pointing at the other part of the museum while holding the box of specimens, she said, ‘Okay. They actually squeak, we have actually got scientists researching them at the moment. And they can scrape their back ends with their legs and make a squeaky noise. Now, this is a group called scarab beetles—feel the legs. Now, this is a scarab beetle. And they have got very rough legs.’

This back and forth question-and-answer exercise continued throughout the whole activity until the end, when Jill smiled and encouraged the students, saying, ‘So you did very well on that, indeed.’ The two students left with a smile and waved back at Jill as they moved toward the other installations.

Multimodal data

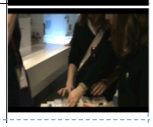
Multimodal Transcript			Total Time: 06:57-14:30			
Group B Students: Charlotte=C, Emily=E, and Museum Educator Jill						
Time	**Participant**	**Facial Expression, Gesture, & Body Movement**	**Participants' Language & Sound**	**Museum Educator's Facial Expression, Gesture, & Body Movement**	**Museum Educator's Language & Sound**	**Supporting Visual Data**
06:57	Emily and Charlotte	Wandered around the interactive screen area and gradually walked toward the stall. They stopped in front of the stall and started touching the specimen boxes. E started pointing at one box and turned to C.	Close Full Screen E: Oh, nice colour. C: Yeah. E: I like that one.	Turned away to clear her throat and observed the two girls' body movements with the specimens.	Yeah, I was just thinking about the possibility of selling the pretty ones in the shop. But then I thought they are...were living animals. Probably wouldn't be quite...really tasteful.	
07:00	Emily and Charlotte	Looked at Jill then looked down to the boxes again. C touched one of the green specimens in front of her.	E &C: Laugh. C: Yeah, I like the colour.	Observed what the students were interested in, leaned both her hands on the stall. Looked up at both students' faces.	Now that's a chafer. Now, the activity is to try and put these beetles in the four groups.	
07:29	Emily and Charlotte	E turned to C with confidence and smiled.	E: Like the one we did over there. C: Yeah.	Looked directly at both students' faces.	Yep. So you've had practice now. Now, I've got a group range from one to five. Then it's the four groups.	

Table 3: Sample of multimodal transcript for Group B

The multimodal data for this scenario (Table 3, see Appendix B for full transcript) were derived from the interaction between two students, Emily and Charlotte, and the museum educator, Jill. It shows active and assertive bodily movements from both students, such as pointing, picking up, and touching specimen boxes. Their initial confidence in touching the boxes with Jill's encouragement indicates their familiarity and comfort with the environment. This may be because the voluntary and mobile nature of wandering around the museum increased the two students' motivation to explore their surroundings and shared interests (Hein, 1998: Packer and Ballantyne, 2002). For instance, Packer and Ballantyne (2002, p.198) found that a free-choice learning environment stimulates visitors' motivation to engage with exhibits. The researchers also suggest that visitors in a leisure setting are more likely

to look for opportunities to learn according to their own interests, therefore being more willing to learn and be more active during their visit. On the other hand, the students' relaxation could also be due to their increasing familiarity with the Cocoon, having learned from the previously encountered touchscreen devices and their interaction with another museum educator. For instance, they were more confident when they came to Jill's stall, as seen in Emily's situational incentive to start the conversation by opining, 'Oh, nice colour,' whilst pointing at the beetle to draw Jill's attention and initiate the activity.

During the categorising process, the multimodal data show that there was an increase in nonverbal social interaction between the two students; they observed the boxes in detail, arranged them into four groups, picked up the boxes, and constantly checked Jill's reaction and facial expression in order to second-guess her expectations and know when they had reached the correct answer. This shows the two parties acknowledging and actively interacting with each other, due to the fact they were able to monitor each other's performance through facial expressions, bodily behaviours, and utterances. This, in a way, provides a collaborative social interaction among the three, but also a positive competition and collaboration between the two students. For instance, both students tried to shout out the answer when Jill asked about one specimen. They also challenged each other's opinions. Yet overall, there was a constant back and forth of explanatory-based feedback, which implemented a more efficient and conscious interaction as a basis for learning (Nietfeld and Schraw, 2002: Kohler, 2002: Coutinho *et al.*, 2005). The scenario in this study is similar to Coutinho *et al.*'s (2005, p.322) case,

although the problem explanations here were imposed by Jill, regardless of whether the students wanted them. The two students, nevertheless, were still motivated to seek explanations in this activity.

In this particular scenario, Jill imposed the problem and question, depending on the two students' reactions and initial motivation to participate, which may suggest their *need for cognition*—the inclination for an individual to engage in and enjoy thinking (Cohen *et al.,* 1955: Cacioppo and Petty, 1982). For instance, Jill was able to elaborate upon the type of beetle that the students were interested in at the beginning, when Emily pointed at the colourful beetle. Jill was also able to answer their question directly to build interest based on their interests. Further, she expressed her personal opinion and displayed a friendly personality, which provided a more friendly and approachable learning environment for the students.

This face-to-face activity contained different types of modes, resources, and information. For example, Jill encouraged the two students to touch the replica beetle (a physical mode), but also passed on factual knowledge when she discussed the scarab beetles and the museum's current research. This echoed a comment by Susanna, one of the schoolteacher:

> No matter how interesting and fun the displays are, [the students] get bored after a certain amount of time. But when they came to interact with whatever it is and also see the real ones, of what can be displayed and can mean in their lives, they find it much more interesting. It was that, and some of the interaction with

> some of the scientists [museum educators] there who presented things, used different ways of showing things, of what can be done, what it means. It was also very good.

Susanna pointed out that if an activity lasted too long, students would lose interest. Therefore, it is important to have a variety of modes, such as face-to-face interaction, physical touching of replicas, and reading information from a device and wall. Having museum educators instruct students facilitates the students' comprehension. Many schoolteachers emphasised the importance of the museum educators, especially in their absence. As Simon, another teacher, pointed out:

> There wasn't enough museum staff for the students to understand other parts of the museum and make it as a whole experience…it was confusing for certain parts of the museum, like the card thing [Nature Plus card]. It would be nice to have someone who can explain this at the beginning part of the museum for us.

Simon's comment indicates the significant role of the museum educators in relation to the museum activities and exhibits. They fill a personal inquiry role, satisfying individuals' needs while also enhancing the linkage between the activities and exhibits. Consider Jill's activity and questions, which prompted the students to remember their experience with a previous device and make

connexions between various parts of the museum learning experience. The students' utterances suggested their recollection of previous parts of the museum experience, further triggering their familiarity with the subject that they were learning.

5.4 Group C

Interactions with different sensory devices, authentic specimens, peer group, and schoolteacher



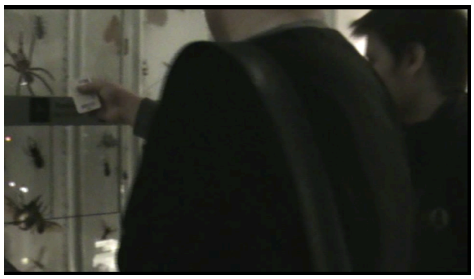




Figure H: Three photographs of students' interactions in three locations, Natural History Museum, London ® Ariel Liu

Figure H consists of three photographs of three different locations in the Cocoon. These images show how two students, Alex and Nathan, related to each other and to the exhibit in these environments and how they constructed their learning experience throughout the visit. There were many other locations beyond the three pictured here that the students visited in the Cocoon that might influence each other, but these three were chosen to demonstrate the students' consistency of approach toward the exhibits and different aspects of their interpretation of their visit.

The first photograph shows the first hands-on interactive touchscreen device, which is located immediately beside the lift. Here, the students listened to the introductory voice-over about the Cocoon whilst moving up toward it. The picture shows the students beginning to investigate one of the devices and the scan system for the Nature Plus Card (see Section 4.2, ② and ⑥**,** for more detail) without any prior instruction from the museum educator. They had to explore the content by reading and following the digital device's textual instructions, watch a simulation, and then use sensory touchscreen tools in order to continue. On occasion, one of their teachers gave them some advice about the basic function of the device if needed. Although the space consists mainly of a digital touchscreen, it also holds some real specimens (*e.g.*, a spider, bees, and other insects) that relate directly to the content of the device. The space also displays large photographs of laboratory coats, gloves, and objects contained in a typical laboratory. The room is well lit by natural light from the large windows. The

area's design scheme—white and minimally decorated—gives the impression of a clinical or lab-like environment.

The exhibits in the second and third photographs are next to each other in the same room (see Section 4.2, ⑤). The second photograph shows a large, interactive cabinet. Although the specimens are stored behind glass, students can touch particular areas to trigger lights to shine on specimens within specific categories. For instance, if one touches a butterfly, the light shines on all other butterflies as well.

The third photograph depicts one of the main touchscreen interactive game devices. The scenario is related to models of mosquitos and some basic textual displays on the mosquito's life cycle, fighting malaria, and one of the functions of DNA sequencing. The models, which depict different stages of mosquito development, are twenty-eight times larger than real mosquitoes and are placed inside a glass cabinet in chronological order. The space is naturally lit by a few windows, but the room is dimmer here, with warm spotlights and some colourful projections from the ceiling. One such projection is a model of DNA that changes constantly, but not many students pay attention to it.

Scenario

The first part of the students' visit reflects the first photograph in Figure H. The scenarios below are three consecutive summarised episodes involving two students, Nathan and Alex, plus their classmates, and their teacher, Beth.

The first episode consists of Nathan, Alex, and Beth. They were the first group of students to enter the Cocoon after coming out of the lift. Nathan,

Alex, and other groups of students paused for a minute, uncertain about how they should operate the device. Nathan turned to Alex, dumbfounded, and said, ‘Wow-oh.’ They then rushed to get to the device, with Alex urging, ‘Go on! Go on!’

Once there, Alex began to touch the screen in front of him and select options whilst saying to Nathan, ‘So what are we doing, mate?’ He replied to himself with a smile, ‘Ah, now this is pretty cool, actually,’ while reading the text on the screen.

Nathan pointed at the screen and replied, ‘Look at that.’ He paused and, realising that his device had some technical problems, murmured, ‘Maybe not,’ in disappointment.

After a few minutes of battling with the technical problem of scanning the card, they realised that Alex had been scanning it the wrong way and decided to use one device together. They also decided to ask for help from their teacher. Nathan stumbled upon some interesting material. Enlivened, he said to Alex, ‘That’s quality. Have a look at your data, once you have selected your data.’ He then turned to his schoolteacher and said, ‘That’s cool, miss!’

After they spent two minutes selecting their items, another group of their classmates entered, and Alex realised that the new group might want to take over their device. He quickly turned to Nathan and said, ‘There we go, I think we actually have to store and scan it first.’ They had already figured out the function of the Nature Plus card, but had not stored anything onto it. Anxiously, Alex asked, ‘Shall we just scan everything?’ but Nathan confidently replied, ‘No, no, just get the one that you want. So let’s just finish it.’ He

pointed at the screen and navigated with his index finger whilst telling Alex, ‘Now click on that one, and then click on the one afterwards.’ Suddenly, a simulation of bees and some textual information appeared on the screen, and Nathan exclaimed, ‘This is good, actually! Really interactive!’

Alex tried to touch the simulation, as Nathan continued commenting on Alex’s decision: ‘Not doing this! Get to it!’ Nathan then pointed out an option on the screen, explaining, ‘What I quite like about this is that it’s interactive, so it’s not like reading or someone telling you about something.’ Alex was still preoccupied with storing the information into the card as another classmate, Tom, walked toward them. Alex scanned his card again and said to both, ‘So you put your card into this.’

As he scanned the card, Nathan chose another option from the screen and said to Alex, ‘Wow-oh, that’s really interesting, like this. Get this bit of information. So it’s all about identification, so. I like this display, don’t you?’ he continued. Alex nodded his head in agreement.

Nathan sounded even more excited later: ‘It’s got more of the visual interactive, and actually the physical as well.’ Alex continued to scan the card as Nathan pointed and said, ‘I wanna see that!’ Alex looked over as Nathan continued gazing at the screen, saying, ‘Now, this is cool. I have read that bit. I actually want to read about the honeybee.’

After a few minutes of interacting with this device, the two decided to move on to the next part of the museum. Two consecutive episodes follow the second and third photographs in Figure F. The first is the interaction with the large sensor glass cabinet, and the second is the students’ exploration of the

mosquito model. As both students had just finished with the device depicted in the top photograph, Nathan was still excited and said, ‘I was trying to see if I could find out about that one!’

‘Nah,’ Alex replied without any enthusiasm.

‘Yeah, I don’t even know why they are walking along so fast.’

‘Cause it’s about *plants*!’ Alex shouted out, slightly impatiently, while walking along the corridor with Nathan.

‘But I still think it’s quite interesting,’ Nathan continued.

‘Yeah—but a lot of the people *don’t*,’ Alex replied with emphasis, and looked away to another exhibit.

Once they arrived at the exhibition of different categories of insects behind the large sensor glass cabinet, Nathan paused and said to Alex, ‘Now, this is more your kind of thing.’

‘Now this is…ah…look at the spider.’ Alex looked up at the top of the cabinet and slowly gazed down to the bottom. Nathan jokily responded, ‘Or, I tell you what, if that ran across my living room...’

His fellow student, Jason, cut him short by pointing at the centipede and asked, ‘What is that?’

Both Roger, another classmate, and Alex answered simultaneously. ‘There is a centipede round there as well,’ Roger said, as Alex replied, ‘That’s a centipede.’

‘Flipping hell! Can I have a peek round, Roger?’ Nathan shouted out, wanting to have a closer look at the specimen. Roger smiled and let Nathan

look at the centipede while warning with a grin on his face, ‘It would rip your fingers apart.’

‘I know that, but I am flipping out! It’s quite a thingy, isn’t it?’ Nathan frowned.

Roger pushed a bit more. ‘If you just look at its jaw, it’s quite black and…’

‘You what? Look at its jaw? Wow-oh,’ Nathan repeated; the room was very loud, and as people were laughing and talking, communication could be difficult.

‘I wouldn’t want to be bitten by that,’ Alex laughed.

‘It’s probably quite poisonous as well,’ Roger continued, and laughed.

Nathan turned to Alex. ‘It is a centipede? Yeah, oh, Alex, didn’t we see that before? Not like in real life, but when we were in…’

Alex turned to look at other specimens while Roger, looking at a type of spider, repeated, ‘That would rip your fingers into pieces.’

Nathan and Alex decided to walk to the other device, and Nathan smiled, ‘It’s really good in here actually, it’s generally good!’ Roger and Jason followed them to the next exhibit.

When the four of them arrived in front of the mosquito model exhibit, Roger said, ‘Wow-oh!’ Jason followed with, ‘That’s huge,’ and Nathan said, ‘That’s pretty insane. Massive!’

Roger asked, ‘What’s that one with the large spike on its head?’

‘Alex, what’s wrong with the huge spike on the top of its head?’ Nathan also asked.

‘That’s ridiculous! The antennae at the top!’ Jason quickly answered.

‘Ar...erm…I know it,’ said Alex, but he hesitated, as he could not remember.

‘I think you told me that one before, isn’t it, like, to flick things over or something?’ Nathan reminded Alex, with vague details.

‘To snag,’ Roger tried to guess, as Alex said, ‘It’s to stab people.’

‘Is it?’ Nathan asked.

‘I wonder why it causes so much damage,’ said Jason, turning towards a different exhibit. ‘This is the biggest one that I have ever seen,’ he added, pointing to another mosquito model.

Nathan turned to Jason and said, ‘Yeah, it’s huge.’ He carried on and tried to draw Alex’s attention by reading out the textual information from the glass cabinet: ‘Yes, see, look, Alex, by removing larval habitats…by pulling out reeds from the edges of rivers flowing through villages. That’s the thing of what they have from the other one.’

‘Yeah,’ Alex nodded

‘That’s a male. No, compare that with the other model. Sorry, so, wait, that’s not that one there, so that is a female and that one is a male?’ Nathan corrected himself out loud.

‘No. I think they are different species.’ Alex leaned against the glass.

‘Are they? I think they are just in different sizes. Yeah, I think…no, I think this is an *Anopheles*. And that’s a female,’ he added, pointing at the model.

‘That’s a female,’ Alex confirmed.

'Yeah, so that's the one that actually transmits it,' Nathan agreed with a smile.

'Yeah,' Alex agreed, and moved on to another exhibit.

Multimodal data

Group C Students: Alex= A, Nathan=N, Roger=R, Tom=T. Schoolteacher=Beth (B)					
Time	**Participant**	**Facial Expression, Gesture, & Body Movement**	**Language & Sound**	**Interactive Device Response**	**Image from the Device**
Scene 1	Alex and Nathan	Both N and A enter exit the lift and enter into the beginning part of the Cocoon. N steps backward and looks at A.	N: Wow-oh, Alex		
01:34	Alex and Nathan	N Turns to Alex and passes his bag to Alex. He then takes his jacket off.	N: Can you hold that for a second? Here you go. Cheers.		
01:49	Alex and Nathan	N looks at Alex and speeds up walking toward the device. He arrives at one of the devices while A rushes himself to follow N.	A: Alright. N: Go on! Go on! Sort it out!		
02:00	Alex and Nathan	N begins to touch the screen and selects an option. He then reads out the text from the screen. A later points out a message indicating that the device is out of order.	N: So what are we doing, mate? Ah, now this is pretty cool, actually. So, stand by the specimens. A: There is a message.	The screen appears to have two options first. It later appears to be out of order.	

Table 4: Sample of multimodal transcript for Group C

The multimodal data (Table 4, see Appendix C for full transcript) for this scenario were derived from the three chronological episodes of Nathan and Alex's interaction with the device, specimens, their schoolteacher, and their other classmates. The three episodes as a whole illustrate a gradual progression in terms of the two students' engagement with the digital device, the authentic physical exhibited material, the textual information, and other students in order to share individual and collective experiences during their visit.

The vocal and physical movements show Nathan and Alex's anticipated opportunity to participate when they saw the sensory technology at the entrance. This kind of movement also occurred in all of the groups in this study, showing their excitement at the novelty and content of the technology. Their exclamations after interacting with the interface, and even when sharing that fascination with their teacher, show their satisfaction with the content and delivery. The technology acted as a portal, allowing the students to approach the resources without apprehension—in other words, presenting students with an interactive device enables a museum to shed the invisible authoritative barrier of the 'do not touch' sign.

The students' body language was simultaneously animated and relaxed. They figured out how to navigate the device through trial and error, repeatedly touching the screen and selecting as many choices as they could. Tapscott (1998) suggests that technology liberates and empowers children, which may correlate with several cases here. This study does not suggest that learning is interwoven with and dictated by technology, but it is also opposed to Boon's (2000) argument that digital novelty tends to distract the attention of the majority of visitors and cause them to neglect the significance of authentic physical objects. Although technology on its own cannot provide the action of learning, it provides opportunities for social engagement and conversations that encourage students to explore further.

Here, as in the scenario with Group A (see Section 5.2), the students worked and discussed as a group. For instance, there was a constant use of 'we' and a questioning of each other to reassure, or to finalise a group

decision. Whilst most of the social interactions were group-based, there was also a great deal of personal interest expressed during the interaction, such as Nathan's interest in honeybees and Alex's explanation that many people do not care for plants. This indicates that the perception of certain exhibits depends on an individual's interests.

Many of the interactions in the three episodes show that a shared understanding and even knowledge were constructed through personal experience as well as individual expression. An example of a personal experience in this scenario is the time when Nathan recalled a previous discussion with Alex. A situated personal expression is an instance such as Alex's statement, 'I wouldn't want to be bitten by that,' Nathan's joking, 'Or, I tell you what, if that ran across my living room,' or Jason's prompted, 'That's ridiculous! The antennae at the top!' These remarks provoked more social engagement and encouraged the students to observe and interact with the exhibits more closely. For instance, when Nathan jokingly expressed fear of the centipedes, this triggered Roger to further describe the specimen's features in detail in order to make this anxiety more 'exciting'. Alex's laughing reaction of, 'I wouldn't want to be bitten by that,' and Roger's laugh and statement, 'It's probably quite poisonous as well,' both contributed some factual information.

The findings here show that the students' level of engagement with the environment is mainly generated by the extent of their motivation to express their personal and shared experiences. The function of the space, resources, and exhibits here is to inspire, relate to, and encourage the students to form

their own interpretations of their visit. The combination of virtual images and reading material as well as real physical exhibits and textual panels facilitates greater access to and control of the learning material, allowing the students to be the researchers. In the sequence of the three episodes, for example, Nathan and Alex started by touching the screen to figure out what they were interested in, reading the textual material on the screen, then viewing the physical real specimens, comparing them with the plastic mosquito model, and going back to reading textual information on the panel about related material. The data show that textual resources, images, and exhibits are key to stimulating students to build their interest and investigate further, enhancing these modes of action. But what is more important is the vocal interplay between the students. One of the accompanying schoolteachers, Erica, stated:

> I am not a biologist, I didn't even know that Cocoon existed and I have not been there [the Natural History Museum, London] since goodness knows when. . . . When I first went into it, I was really sort of phased out by what on earth was going on, cause I am not very technical-minded. And I noticed immediately that the lads knew exactly what they were doing and how to do it. They were actually showing me what to do. And I think because they were showing me how to do it and were telling me what it is about . . . and I actually learnt about an awful lot that I had never known before, so it was great for me. And I learnt a great deal, and in that, so did the lads who were walking around and telling

me, because it put it into their heads, because they had to explain it to me.

In this case, Erica reiterated the point previously raised of how the young people were more familiar with the technological device than their teachers, even without prior instruction. Another noted point is that because the students were forced to explain to their teacher how the interactive technology worked, they were able to reconstruct the unfamiliar resources as something more beneficial for others, but also for their own education. Erica emphasised that by enabling the students to teach their teacher, the exhibit enhanced the students' understanding of the given material and improved the cognitive interaction between the students and teachers.

5.5 Conclusion to Part A

This study deconstructs many scenarios to understand the 'how' and 'why' behind the complex interactions between students and their engagement with technology-driven multimodal exhibits. This chapter has investigated and answered the 'how' in relation to scenarios from the Natural History Museum. The three scenarios relate to the students' engagement with the primary investigated multimodal technologies, museum educators, physical authentic exhibits, and the activity as a whole. In order to discover the 'how' factor, this chapter has deconstructed the architectural layout of the museum in conjunction with descriptive scenarios and multimodal analysis to build a holistic yet micro-level account.

The findings in this chapter illustrate that students' physical, aural, and visual modes of action and interaction are derived from vocalising their thoughts (*i.e.*, talking out loud), which are then followed by scaffolding ideas together in combination with each other. This reciprocal relationship has been particularly discussed in Abrahams and Millar's (2008) study on how learning science through practical fieldwork can enhance science theories and understanding. They stress the importance of teachers giving students more time to express their process of thinking and talking whilst executing the action (*Ibid.,* 2008). Similarly, this study shows how social and cognitive engagement among students is developed through talking and sharing personal experiences, looking at and reading images and text, and participating in an activity with museum educators and sensory devices. The students' interactions were active, multimodal, and constantly seeking answers. Although these scenarios, observations, and interactions cannot be generalised, as not every group of students was as constructive and active as the particular groups studied, the analysis reveals that the students' physical interaction increased with their physical involvement with the multimodal exhibits. This physical involvement included observing the specimens, reading textual information, navigating the route in the museum, participating in the museum activity, touching the screen, making selections, touching physical authentic exhibits, and discussing material. This physical interaction built a foundation for the later conversational, social, and shared structures or topics by which they could further relate their situated personal expressions and

experiences, as well as their previous experiences, which will be further explored in the following chapters (see Chapter 5, Part B, and Chapter 7).

Part B

5.6 Introduction to Part B

This second part of Chapter 5 discusses the findings with respect to the Natural History Museum relating to the second operational research question:

> *To what extent and in what ways do these engagements result in experiences of learning?*

It extends from Part A's scenarios and focuses on the students' perspectives in an attempt to determine how these students' interactions relate to their learning experiences. Here, the term *learning experience* can include developing new personal interests, sustaining prior knowledge in relation to school curricula, or enhancing one's learning experience in the longer term. The data in this chapter are derived from semi-structured and stimulated recall interviews conducted on two occasions with the students, first at one week after their museum visit, and then at six to eight months after their visit. This presentation draws on quotations from the students' interviews and their reflections on the selected scenarios during the stimulated recall interviews.

This section, to some extent, reiterates the issues and observations raised in the previous section; it focuses on how the students construct their understanding and behaviour when visiting a new part of the museum. Hence, the attention here is concentrated on the extent to which the museum's

multimodal technologies have been used effectively to support their learning, whether individually or in groups. Additional consideration is given to the ways in which these outside-school interactions and experiences affected the students in the longer term.

The findings suggest that due to the nature of the subject they encountered at the Cocoon, the students were able to relate certain parts of their visit to school materials as well as to their personal interests. The multimodal technologies proved essential in motivating them to participate and actively engage with the content of the museum. They also made the learning environment more accessible and served to empower the students' relationship with the museum. Moreover, the combination of virtual and physical interactions reinforced the students' social interaction, discussion, and enjoyment of the overall learning experience.

5.7 Accessibility and initial engagement

The students frequently mentioned the 'planning your expedition' device during their interviews. All of the participating students cited this as the most memorable and exciting part of their visit. On one hand, this is due to the vibrant illumination and architectural presence of the device, which attracted their attention; on the other, the students were drawn to the physical 'virtual touch' aspect of the device, which they found to be empowering. As Alex from Group C noted:

> [The device] was more interactive 'cause you can touch it. You pick certain options and what to do with them. I think the text on the wall kind of disappeared 'cause the screen was very bright so you kind of just go for the screen instead.

Alex highlighted the importance of 'hands-on' involvement—being able to control freely and to select on his own terms. Looking at this particular device, the accessible and comprehensive content was another crucial factor, as illustrated by an example from Group A. Chris commented:

> I think although we learn about science in general we don't really appreciate how complicated an expedition is until we go into the museum and they put everything into perspective. The interactions [with the device] you could do were quite advanced compared to some of the media that we were used to.

He alluded to the complexity and unconventionality of the device, which allowed the group to experience a level of 'real' physical interaction. For instance, consider Amy in Group A, who exclaimed, 'Oh, you drag it! Oh my God!' when she realised how the device worked (see Section 5.2).

Chris indicated that using the multimodal technologies and the digital 'hands-on' game involved a more complex level of interaction than would be anticipated in a museum. He appreciated the underlying intricacy of the

design and the necessary preparations for a science expedition that a scientist would have to undergo, and offered further comments:

> I think having things like sound, images, and video, is kind of like grabbing your attention. I know in some places it might not be a good idea because there were so many things going on. But especially for a museum, because museums have a bad reputation of being boring, like, 'Oh, I guess we are going,' but at least they have got sound, you got things to interact with. It makes it more of an experience.

He found that the multimodal technologies were attention-grabbing due to the stimulation of the senses from different representations (such as sound and video), but also noted that such features retained his interest and made him more proactive and positive. This reflects many early museum-based learning researchers' findings that visitors' initial attraction is based on curiosity relating to sensory stimuli such as sound or, as in this study's case, the bright screen (Csikszentmihalyi and Hermanson, 1995; Sandifer, 2003). Sandifer (2003) also points out that young people (Cole and Cole, 1996, cited in Sandifer, 2003) are naturally attracted to or would be more focused on loud noise or movements. Although at this stage the students' attraction to the device was more of an initial fascination than a deeper engagement with the exhibit or even a state of learning, all of the students considered it to be an important platform from which to begin their experience.

Continuing to analyse Chris's statement, he also indicated that due to the presence of such attention-grabbing features, his initial expectations of the museum were transformed from boring to interesting. This may reflect the argument of some researchers that technologically rich exhibits attract and sustain visitors' attention due to the technological novelty value (Sandifer, 2003; Meisner *et al.*, 2007). This is not to say that technology is the sole factor affecting students' engagement, but to reiterate that the nature of learning in museums, even with activities, is generally not a linear, composed sequence. It relies heavily on voluntary qualities such as curiosity, motivation, personal interest, and prior knowledge (Falk and Dierking, 1992; Griffin and Symington, 1999; Bamberger and Tal, 2006). In addition, new visitors tend to have a shorter attention span and a less continuous sequence of visiting experiences when in an unfamiliar environment (Bamberger and Tal, 2006). Hence, the practical aspect of the accessibility of the device, simple textual labels, and aesthetically pleasing interface are key to promoting and opening the content for the visitors before any learning can take place.

5.8 New and multimodal technologies

Based on the students' interviews and the notion that a student's initial attraction is centred on sensory stimuli, the data suggested that later development and engagement that relates to learning is dependent on the individual. This section will explore the rationale behind the students' willingness to dedicate further attention to reading the text, interpreting the

content, and interacting with the digital devices, using the analysed scenarios in the previous chapter.

The scenarios indicated that the students became more active in their bodily movements after their interaction with the multimodal technologies. Subsequently, they vocalised their thoughts to share their personal experience with their peer group. This is not to say that the technology was the sole instigator that provoked their interests and actions, however, but the scenarios did show an increase in physical activity after interaction with the device. For instance, Roger in Group C pushed a little harder on the sensor-based glass cabinet while commenting, 'If you just look at its jaw, it's quite black' (see Section 5.4). Through his action of pressing the sensor, he became more active in explaining his observation to the rest of the group. Alex interjected, 'I wouldn't want to be bitten by that,' and Roger continued, 'It's probably quite poisonous as well.' To some extent, the physical 'touch' erased the obstacle of the 'do not touch' impression given by the traditional museum presentation and liberated the students from their preconceived restrictions. As Charlotte in Group B (see Section 5.3) noted:

> I think the best part of the exhibition was the touchscreen ['planning your expedition' device] because it's a bit more interesting than just reading text or just pictures because you have something to do. You are actually doing something rather than getting told what to do.

She confirmed the active involvement promoted by the museum. Even just touching the digital screen was clearly more stimulating and liberating for her than the two other itemised modes, reading text and looking at pictures.

But the devices were not the only features of the Cocoon that scored highly with the students. Charlotte's group also had the opportunity to interact with the museum educator, Jill. Physical face-to-face interaction was highly praised and appreciated by many students. They also believed that the question-and-answer mode was tailored to their individual inquiry. Amy from Group A (see Section 5.2), after describing her experience with the multimodal technologies, made a particularly telling point:

> Old people always think that we want the latest technology, but really, we just want something more straightforward and easy to use or someone who can explain stuff for us when we have a question.

Her frank expressed opinion touches on the debate over whether technology has become so embedded in young people's lives that it is necessary to install the latest digital wonders in museums in order to attract their interest (Tapscott, 1998; Prensky, 2001). Amy also criticised the general presumptions concerning young people's readiness to adopt the most recent technology without evaluating their underlying rationale, such as the need for simple communication in conveying straightforward knowledge, with and without technology. Such assumptions overlook students' genuine needs. It

cannot be denied, however, that Amy's desire for 'something more straightforward and easy to use' may sometimes be met only by the latest technologies. Her comment also raises the problem of the lack of museum educators in the Cocoon due to the museum's concerns over funding and training budgets, as most of the museum educators are volunteers.

In most of the stimulated recall interviews, the students tended to begin by describing their memories and visiting experiences, followed by associating their forms of description with their own concept of ways of learning in such an environment. An example can be seen with Steve in Group A, who explained:

> The device felt like a game but it's actually not because it got us involved and we could have got it wrong. When you get it wrong you can learn from your mistake. For instance, the 'backpacking' one has three options, and when we choose the wrong one, at the end they would tell us that we were wrong and tell us why we were wrong. So we really learn from our mistake. And that makes you remember it as well because I can't remember those texts, but I can remember the backpacking thing.

Steve attributed his satisfaction with this experience to the physical participation with the technology, which provided an entertaining and educational experience. He was able to describe the game's challenge through navigating, manoeuvring, and decision-making, but was also able to evaluate his own behaviour in relation to learning. To this end, what Steve

learned was not precisely the content or factual information provided, but rather the process of making judgments and decisions as an effective learning method. This echoes the definition of Weil and McGill's (1989) concept of learning experience (see Section 2.5). Even though one may criticise the lack of retained factual information, the fact that a student is able to articulate his opinion on his own learning process and how he may be benefiting from such an activity should be considered valuable.

Understanding the process of learning was a recurring theme, especially with Emily from Group B, who commented:

> I think it's really interesting, rather than just the science itself. But how, like, people actually go out and find information themselves, it makes us participate in this 'expedition', you see.

Like Steve, Emily emphasised the process of researching and finding pertinent information, but also discussed the involvement entailed in being part of the adventure provided by the museum. This allowed her to be interested in the process of research beyond science as part of the school curriculum.

This self-conscious analysis of personal behaviour and learning methods was evident throughout the student interviews. Through interacting with the multimodal technologies, the students became more alert to the types of learning methods that the museum conveyed, in contrast with mainstream learning. Nathan from Group C stated:

> The kind of technology and science we have in school is more descriptive. Like, you are trying to read text while trying to refer meaning to a situation that you were given, as opposed to when we were with the machine. It gave you some feedback as well, so you choose that as an option. I thought that was really interesting 'cause it can tell you where you have made it wrong.

Nathan illustrated the differences between his school's teaching methods and those delivered by the multimodal technologies. He believed that the museum conveys more practical, hands-on information and advice in comparison with the more explanatory and theoretical approach that characterised his school's science lessons. This allowed him to develop appreciation and awareness of the two types of teaching in understanding his learning topic.

5.9 Combining different learning methods

One argument that is relevant to these students' experiences with the devices is that to some extent, non-assessed and informal learning is potentially beneficial because it stimulates students to think unconventionally and provides more positive attitudes towards learning (Falk and Balling, 1979). This section discusses the ways in which the students thought about their interactions with learning, both inside and outside the school context.

In the majority of the interviews, the students seemed aware of their learning processes during their interaction with the multimodal devices, but

they also tried to relate what they encountered during their trip to their school curriculum. For instance, Nathan from Group C commented in the semi-structured interview:

> I think a lot of things were related to our school stuff. Like, you got the biodiversity aspect of it, and stuff about taxonomy. You have got the one organism. I know we were looking at the things like the mosquito and trying to find information about that in our trip. And identifying different animals and species that were related to what we are doing in school.

Most of the students acknowledged the entertaining nature of the school trip with their peer group, but like Nathan, they were also aware of the potential learning value that they could apply towards their school materials. Alex of Group C stated:

> We did some stuff about malaria in biology a while ago, so that kind of links with what we were doing. . . . [W]hen it says stuff about, like, the female mosquito carries stuff, we knew it all before, but I think it's more for people who haven't learnt it before, who can come here and learn it.

Alex was able to relate the topic of malaria from his biology class to what he saw at the Cocoon, but he also suggested a lack of challenge, as he believed

that the presented information was for people who are unfamiliar with this topic. In a number of cases, students were able to connect recollections of their prior school studies with what they saw at the museum. Through different forms of representation, such as multimodal technologies, textual panels, and authentic exhibits, the students were allowed to recollect and reinforce portions of their pre-existing knowledge during their interaction. Following such interaction, they might discover new knowledge. For example, Steven from Group A mentioned, 'I remember that you use a pin to store insects, I didn't know that before.' Amy from Group A said, 'I remember the clothes that they took from the backpacking thing. And you use tweezers instead of something else.' These two students had a general foundation of scientific knowledge, especially biology, but through the additional interaction with the 'planning your expedition device', both were able to adopt and retain new information as well. Charlotte from Group B expanded upon this concept during her interview:

> [T]he interactive ['planning your expedition' device] helped because it's something different to what you are normally learning about. It's more of a unique experience as well. . . . It's just something you would remember, but you know, you can, you go around it so many times and pick up new things. I think it makes you want to go back there and have a bit more time there, really.

She explained that the alternative information delivery method was different to the mainstream school teaching style. She found it to be a ‘unique experience’ to spontaneously and autonomously select and explore on the basis of her own interests and prior understanding. Charlotte also suggested that the attractiveness of such a learning method motivated her to acquire more information, time permitting. This also raises the issue that Abrahams and Millar (2008) emphasise regarding the importance of allowing enough time for students to process new knowledge through thinking, discussion, and activity.

Some of the students, beyond praising the benefits of multimodal technologies, discussed the appeal of the authentic artefacts. For instance, Steve from Group A explained:

> I also remember that before this exhibit [‘planning your expedition’ device], that there was a real syringe on the table. And later on when I see it on the device, I instantly can relate to that because we don’t really know how big it is and what does it do . . . but with the real thing we can sense what it is for . . . and this reminds me of what we did in our classification class.

Steve explained the usefulness of seeing the authentic artefact, as he and his peer group found it difficult to comprehend the actual size of the artefact when looking at the digital images only. Having this experience reinforced his prior knowledge from his biology lesson on classification, and suggested that ‘real’ scientific experiences can help cement what students learn by merely reading.

More broadly, most of the students could relate the Cocoon experience to their science education. As Amy from Group A noted near the end of her interview:

> Most of the things that I learnt there was the scientific process like finding information. I also think it's good to go through this as a group because for the activity, you can discuss the options that make you think about what you are doing.

Amy discussed the sociocultural context of learning through group conversation and observation, which is frequently mentioned in museum-based studies (Griffin, cited in Falk *et al.*, 2007). She also acknowledged that the overall learning purpose of this museum is to understand the scientific research process. This reflects one of the goals of the museum, which is to represent 'how scientists work' in inspiring the visitor to be interested in science as a topic. Chris, also from Group A, added to this point:

> There was a novelty of it being in a school trip. But the best thing is that we can see a life of being a scientist . . . seeing them at work was the main thing, it was somewhat more real. That sort of made us realise that the sort of thing we do at school and what the scientists do there at the lab are quite similar . . . but of course not exactly what they do. But just by seeing that, makes us feel, I guess more (.) big.

Chris regarded this experience as new and entertaining, but also conceded that the comparison of what they learnt at school and what they saw in the museum is instructive. He became more appreciative and confident of what the school provided, which had inspired him to explore his interests and a prospective career as a scientist. Chris in particular seemed to understand the connexion between his schoolwork and one potential end—a job as a scientist at the museum.

5.10 Personal experience and school curriculum

This section further explores the ways in which the students reflected on their meaning-making process as a whole. Many of the students discussed their reasoning behind interacting with and evaluating different representations of exhibits in relation to how they constructed their learning experience.

As discussed above, the use of multimodal technologies is a prevalent method of allowing students to familiarise themselves with a new environment. The majority of the students believed that their learning experience is fostered through the different sensory stimuli entailed mainly in using such technologies, as well as other exhibits. Yet they were also aware of the function of the museum. They considered that its general function, including the Cocoon, was to serve as a repository for artefacts and specimens. Hence, when connecting their experience with learning, most of the students felt more

comfortable relating their understanding with certain features of the artefacts they had seen (see Sections 5.3 and 5.4).

When the students were asked to summarise their overall experience, many instinctively became critical and analytical in reflecting on what they considered to be important, especially methods for their learning. For instance, after describing her interactions in the museum, Amy from Group A asserted:

> It was good that you were able to look into what the scientists were doing and look into the lab from the Cocoon. I think it shows how the scientists work instead of how we think they work.

Her appreciation and comprehension of seeing the scientists work in the laboratory indicates her realisation of what she learnt. Her comment also indicated that her prior knowledge of a scientist's job had been changed by seeing a more genuine representation. In this, the Cocoon was a success. As Hein (2004, p.422) indicates, the function of an exhibit is to 'make connections to issues of interest to the learner, and provide guidance for applications in the world outside the museum.'

In the same group and in a similar context, Nathan gave further expression to the effect of such an experience in relation to his concept of learning:

> [W]hat's inside the Cocoon [authentic exhibits] and the devices [multimodal technologies] are kind of related, because you can see the insects around the Cocoon, and understand how the leading scientists are contributing, and then relate them both together. I think it's more of a learning experience than a learning curve. Then it just makes you think more outside the box, than just straight biology and chemistry.

Nathan pointed out the connexion between different exhibits and devices in the Cocoon from his observation. He illustrated how such a 'learning experience' affected his understanding of the differences and similarities between school subjects and the content of the exhibits, thinking beyond the classroom as a result. He also emphasised the positive nature of the 'learning experience' in the museum, which was more enjoyable and less predictable than the expected outcome of the classroom, or of a traditional museum. This, in a way, demonstrates the effectiveness of helping students become engaged with the content of a museum by using a greater variety of representations (such as multimodal technologies), which allows them to compare and reflect on both their new and previous knowledge within a broader framework.

As mentioned (see Section 5.2), most of the students became more aware of their own learning preferences, and thought creatively about what might improve their understanding about the subject and their motivation to learn. For instance, Emily from Group B suggested:

> When you are reading text, it's quite easy to lose that desire to learn, but when you have a question, you kind of set yourself a challenge. So, you know, that's a key thing for learning. It gives you this desire to learn, so that challenge, I think actually helps you to learn and gives you that motivation.

Here, she referred to the moment when Jill, the museum educator, told her and Charlotte to separate beetles into different categories (see Section 5.3). Emily also favourably compared answering questions with Jill or with the device to merely reading text from a panel. She suggested that learning by just reading descriptive information has the drawback of reducing her motivation to continue, whereas using questions provided a challenge and the encouragement to focus on learning more about the content. Inquiry is an active approach that encourages effective participation in building knowledge. Many museum-based studies agree on the efficacy of the use of open-ended questions to provoke conversation and collaboration among visitors in order to construct and share knowledge (Ash, 2004; Ash and Well, 2007; Hohenstein and Tran, 2007). These researchers believe that through group interpretation, information may be made relevant to participants' lives and schools, and that learning becomes more meaningful and engaging (Griffin, 2007).

Another aspect discussed by many students was critical thinking on the ways in which the museum could improve visitors' understanding of the content. For instance, Chris from Group A stated:

> I think it's better that you can work things out yourself because you learn more about it and appreciate it more, because you have done it yourself as opposed to someone telling you what to do. Even though I think it's good to have a teacher to help you out and support you. But to be honest, it's not that hard to figure things out yourself there.

He expressed his preference for a particular type of learning, which is to complete an activity with the multimodal device or to discuss an issue independently with his peer group without his schoolteacher's presence. This was considered to be a more satisfying way of learning about and appreciating the exhibits. For him, the accessibility of the information from the device and other exhibits should not be an obstacle—rather, the devices presented a positive challenge and the freedom of choice. This indicated that, for some students, while they acknowledged the presence and helpfulness of their schoolteacher, they were capable of independently relating the content to their schoolwork. Although this may depend on individual interests, learning preferences, and proclivities, the majority of the students suggested that having an open learning objective, a limited prior understanding of the exhibit topic, and additional time would allow them to engage more effectively with the museum.

One issue that was raised by Sharon, one of the schoolteachers, was that crowded spaces may reduce students' interest and motivation to engage

(see Section 5.2). Steve from Group A pointed out a similar problem and concludes:

> I think it's good if we take our time on it. As you saw with the rest of our class, they just went through it as fast as they can. It will be great if someone from the museum guides us a bit but gives us enough time to use the machine, we would really learn more about it.

With additional guidance from the museum educator and more time to engage with the content of the multimodal technologies, Steve thought they could have engaged more with the content and learnt more about the museum. He also observed that due to lack of time and space, some of his classmates did not spend enough time interacting with the device and reading the text, and thus, they did not appreciate the exhibits. This indicates that not every student had the chance to fully engage with the content provided. A student's learning behaviour can be disrupted by a busy environment, as in the crowded Cocoon. This implies that engagement and learning are strongly connected, as not every student learnt in the museum, but that with more engagement and guidance, learning might be more likely.

5.11 Conclusion to Part B

This chapter has further discussed the students' interactions in relation to their perceptions and associations with the learning experience. The two

chapters (Parts A and B) suggest that students benefit considerably from accessing information through sensory stimuli from the architectural, spatial, and technological arrangement—that multimodal technologies increase their attention, motivation, and curiosity to engage intuitively with the exhibits. This is not to say that technology is the only effective method for student engagement, but when students enter an unfamiliar space, the active physical involvement aspects take precedence over their conceptual participation. As some of the students clarified, providing a direct learning objective and straightforward content interpretation is more beneficial and engaging than having advanced technologies with overly complicated systems and interpretation.

For most of the students, the learning experience in this museum made them realise there are different learning methods and means of content delivery, especially on the topic of science. They were able to make judgments based on their individual preferences for consuming new information or assimilating prior knowledge from school. Some of the students emphasised the impact that group interactions and conversations made—they obtained a better understanding of the practical as well as the theoretical aspects of scientific learning and of being a scientist. The majority of the students had a more positive attitude after their visit, and some even developed more enthusiasm toward the subject beyond school. However, many of the students commented that in order to fully engage with and appreciate the content, they needed not only a clear learning objective and possible face-to-face guidance, but also sufficient time to allow them to

critically analyse the relevance of the museum content to their interests and prior experience.

Chapter 6: Findings: Churchill Museum, London, Part A

6.1 Introduction to Part A

This chapter aims to answer the first operational research question:

In what ways are school students engaged by technology-driven multimodal exhibits in museums?

The data used to answer this question are derived from the video data, field notes of the students' interaction, and semi-structured interviews conducted with the schoolteachers and museum educators. It is an overview of the students' physical and social interactions with the multiple modes presented at the museum from observer's, schoolteachers', and museum educators' perspectives. It descriptively and analytically constructs relationships among the students, the museum activity, the multimodal technologies, and the students' social interactions. As with Chapter 5, Parts A and B, the overview provided by this chapter will be used in Chapter 7 to further explain the ways in which the students engaged with learning. The data here cannot be generalised due to the social and cultural complexity of the individual differences among the students and the numerous variables present, such as the type of activity, the museum educators on the day, and the nuances of the technological device. Nevertheless, the data build an overview of how a museum activity, digital devices, and other museum resources influence students' behaviour.

Structure and presentation of the chapter

The structure of this chapter is similar to that of Chapter 5, Part A, but this chapter presents data from the Churchill Museum. It introduces the context of the museum, its activity, and a summary of the chosen student groups. Three groups of students (Groups D through F) were observed in three different scenarios in this museum. A photograph with a brief account of a scenario involving each group is used to outline the spatial relationship among the students, the devices, and their environment. This is then connected to specific multimodal data derived from the video, the interview transcripts, and visual documents provided by the students. The multimodal data were transcribed into dialogues of punctuated written form, with some references made to body movements, gestures, and facial expressions.

Additional photographic documentation was used to enhance some of the visual interpretation. In the same vein as the audio recordings, the utterances were transcribed as accurately as possible. Certain unfinished utterances were written in full, to match the participants' intentions while making the transcription as legible and clear as possible. The repetitions of words, or instances where students shifted focus in mid-utterance or did not complete phrases, were marked by '(.)'. A long pause during an utterance is symbolised as '…'. In order to further clarify the description of the students' actions, photographs were attached to correspond to particular moments.

Group D consisted of two students, Chelsea and Dominic. Section 6.2 analyses their interactions with their schoolteachers, Steve and Jason, the museum activity, and many exhibits. Group E also consisted of two students,

Hannah and Kate. Section 6.3 discusses their interactions and interpretations of the museum activity with the main 'Lifeline' (see ⑥). Group F was comprised of four students, Ellie, Laura, David, and Peter, and Section 6.4 looks at their interactions with the museum activity, textual panels, and other exhibits in seeking to examine the ways in which they interpret the content of the digital devices and textual panels in relation to the whole museum learning experience.

The three chosen groups of students had never been to this museum before. Like the students at the Natural History Museum, they were told to spend a slightly longer time with the chosen multimodal technologies for the purpose of this study. The three groups came from different schools outside London. Therefore, the differences in their schools may have affected how the students behaved and understood the material. That, however, is not the main concern of the research question, and it is not discussed further in this study.

6.2 Group D

Interaction with schoolteachers, the Lifeline and activity



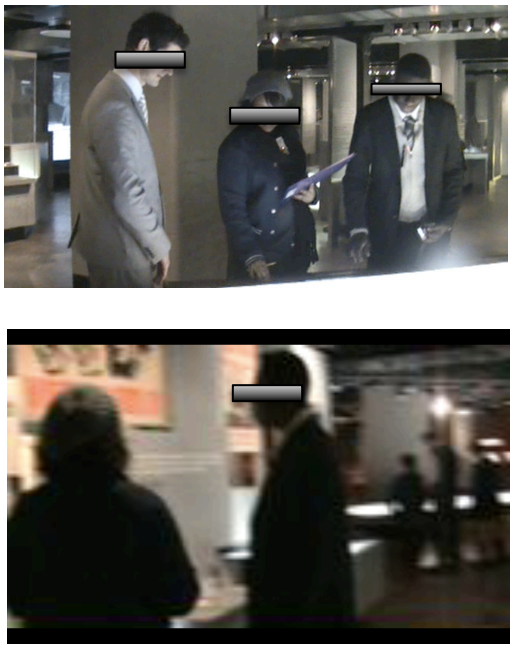


Figure I: Three photographs of students' interactions in three locations, Churchill Museum, London ® Ariel Liu

Figure I consists of three photographs of three different locations in the Churchill Museum. These images show how two students, Chelsea and Dominic, began their museum activity in the learning centre, followed by walking around the digital room with their schoolteachers, Steve and Jason. They illustrate how these students constructed their learning experience through their interaction with the teachers and the chosen device, the Lifeline. Many other locations and digital devices beyond the three pictured here may have influenced the students' understanding and aspects of their visit, but these photographs were selected to demonstrate the consistency of the students' approaches to the exhibits.

The first photograph in Figure I is of the interior of the learning centre, where the twenty-minute museum activity took place prior to the students' visit to the digital room (see Section 4.3, ⑤). It illustrates how the students were

situated around the whiteboard table, gathering and writing down ideas about the characteristics of a good leader. Each table holds four to five people, and is positioned against the wall where most of Churchill's propaganda posters are placed. The room is well-lit, yet the low ceiling and rectangular shape of the room make the space slightly crowded and claustrophobia-inducing when there are more than thirty students present. The standing figure in red is the museum educator, who walked around each table to assist students; the schoolteachers sat in the right-hand corner of the room. Due to the small size of the room, the museum educator was able to supervise the students and pay attention to their responses. The whiteboard table was actively used by the students for writing ideas as well as personal illustrations and even doodles during the activity.

The second photograph shows the low ceiling of the space, which is also partitioned by many life-sized textual panels. Each panel contains a famous Churchill quotation, cartoon, or photograph related to his life events. The room is very dim, as the lighting is generated by the digital screen only, apart from soft spotlights for the textual panels and some glass cabinets. The Lifeline has a fifteen-metre digital screen panel, which divides the digital room into two parts; its colourful and strong lighting attracted most of the students initially. The photograph demonstrates how most students stood alongside the table, looking down at the screen and leaning against it, which suggests they are relaxed. After interacting with this device, most students became more active and less cautious toward other digital devices as they began to

acknowledge that there were more ‘hands-on’ opportunities, as opposed to just textual materials to be read.

The third photograph displays the spatial relationship between textual panels and the Lifeline from the far distance. The two students spent more time looking at the textual panels around the table. It also shows how different digital screens are placed in various spaces, which allow students to look at them from different angles. In common with the second photograph, this picture shows the lighting effect as a key element in drawing students’ initial visual interest and piquing their curiosity.

Scenario

Once all the students were sitting down in the learning centre, the museum educator, Sandra, began by asking them to pair up, start gathering ideas, and write on the whiteboard table what they considered to be the two most significant characteristics of a strong leader. Chelsea turned to Dominic with a smile and said, ‘You have to be reliable.’

‘Definitely, confident,’ he replied. ‘Because confidence, it’s a bit, because you have to be confident in what you are choosing about.’ He spoke while still texting on his mobile phone.

Chelsea began to write on the table with the whiteboard pen. ‘And being confident means you are a good speaker. I think confident and reliable. Confident is a root of most of it,’ she further asserted as she circled the word with a line drawing of a cloud.

‘Reliable.’ Dominic stopped texting, nodded, and looked at her writing.

Chelsea carried on writing other characteristics on the whiteboard while speaking slowly. ‘Confident in the…’

He cut in, ‘It has all of these things in it, yeah.’ He paused a few seconds, then continued, ‘Because without confidence you can’t speak to anyone.’

She nodded. She put her pen down and added quickly, ‘And morals, yeah, society will affect your morals, you know what I mean, because you would be different than everyone else,’ then continued writing on the table.

Dominic rested his left hand against his chin, slowly slipped his phone into his right pocket, and looked at Chelsea. ‘Confident, yeah, and so brave, being brave is also courageous-minded.’

‘Yeah, confident, yeah, and being reliable makes you, like, for the people, and it makes you willing to share ideas, and it makes you tactful, because you have reliable ideas, so reliable and confident, yeah. And it makes you opinionated, your confidence, because you will be able to share those ideas.’ She replied to Dominic’s statement with a frown.

Later, Sandra began to brief them about what they were going to do in the digital room. ‘What we are going to do next,’ she explained, ‘you are going to need to try and find some evidence to see whether Churchill fits into those expectations, much of those expectations of what you think a strong leader should display and what you think a strong leader should be like. You are going to do this by looking for evidence in the Churchill Museum, to see if you can find things that match up with Winston Churchill’s ideas about the

leadership that match up with things that support or contradict him and the way he displayed leadership skills.'

After the briefing, the two students along with the rest of the class entered the museum and began by quickly browsing some textual panels and authentic objects with students from the other groups. Dominic began to look at authentic exhibits in a glass cabinet, but when they stopped at one of the textual panels, he asked Chelsea, 'What were your two words that you…?'

'Confident and reliable,' she drawled, facing the panel. Soon afterwards, she tried to clarify her statement: 'And the most, confidence, not reliability. Yeah, but I think that if you are confident and reliable as a leader. And it shows, like, other values, because we wrote a lot of things like strong-minded, opinionated, you have the confidence to be that.'

'That might include other things,' Dominic muttered.

Chelsea noticed that he had less interest, and so began to ask more questions to provoke him. 'And the reliability sort of links some of those things as well. Yeah, so where do you think you might look to find one example of him being reliable, that is going to be tricky.'

'Probably in the war, maybe,' Dominic replied while still browsing other cabinets and textual panels.

'Yeah, yeah, maybe where he was quite good at that because he says he is going to do something and then he does it. Right, because he worked through the coalition. Maybe we should take a picture of ourselves. My microphone thing keeps slipping. Where is everyone?' Chelsea looked at Dominic and began browsing other exhibits heedlessly.

‘They are outside,’ said Dominic. ‘He always has a cigarette in his mouth. You should take a picture of that whole cigar thing,’ he replied while pointing at an artefact in a cabinet.

‘They made him a dog, oh. Did you know that the Churchill dog, was it named after him?’ she exclaimed, looking at the same cabinet. She pointed at the little ceramic miniature of Churchill’s head with a dog’s body.

‘It might be, you know, actually,’ he replied, looking at her as she turned towards their schoolteacher, Steve.

Chelsea asked, ‘Sir, you know the Churchill dog, for the Churchill in that advert, was it named after him?’

Steve smiled and quickly replied while rubbing his palms against each other, ‘Yeah, which is weird, because now when you Google “Churchill”, you get these insurance options and it kind of taints the name a little bit.’

‘Uh-huh.’ Chelsea smiled, but all of a sudden, she stepped into a sound sensor device.

Dominic whispered at her, ‘Well, this’—pointing at the two audio devices—‘happens when you walk in front of it.’

‘I know, I was quite scared!’ Chelsea yelled.

Steve looked at the two students and asked, ‘So, what are the two features you are really looking for?’

‘Confident and reliable,’ Chelsea immediately said.

Dominic smiled. ‘Confident and….’

Steve smiled and looked at the Lifeline. ‘Oh, okay, confidence and reliability. So you have got Soviet and the other thing? This is hard. He builds

confidence by doing a lot for his allies, for some of the countries that they were allies with before in the war.' He then allowed the two students to discover for themselves and disappeared to another part of the digital room.

Both students then began to walk toward the Lifeline. Dominic paused at a picture of Churchill and said, 'Hmm.'

Chelsea pulled up the museum-given camera and turned to Dominic. 'Take a picture of me next to his picture, because it would look funny innit. Hold on.' She posed as Dominic took a picture of her and smiled. She then looked down at the Lifeline and tried to touch the projected images on the table, and said, 'Wait, let's look for dates to see if he was reliable. Because if he said he was going to do something, in his, like, manifesto to be the Prime Minister, then he should of have, erm, like.'

Both of them looked at the table and began to play and figure out the function of the control bar. 'It's like a folder, isn't it?' Chelsea remarked, as Dominic continued to play with the strip bar alongside the table. 'When was the date that he became like Prime Minister?' she asked.

'It was, like, 1940, you know.' Dominic turned his head toward her as Chelsea turned toward Steve again as he walked past.

'Sir,' she asked, 'do you know when Churchill became Prime Minister for the first time, because we are trying to look for his reliability in his, like, manifesto.'

Steve rubbed his hands. 'Yeah, I think it's about 1940, I think, the war had just started and there was a Prime Minister, Neville Chamberlain, and so

yeah, May 1940, Churchill becomes Prime Minister.' While he tried to open the digital file, he murmured, 'How does this work?'

Chelsea spoke out loud while trying to operate the files. 'You touch that—ah, what is it doing? Yeah, it's on the wrong one. Okay, I am trying to, okay. What's it doing? It won't open. This is so confusing. Try it, try to go that way? We need you. It is not opening. My gosh, okay, we are trying to look for reliability resources. We can't find any. Oh. Okay, I think I managed to open. What have I done?'

'Yeah, I think you just hold it on it, and it will open.' Steve finally figured it out and turned to the two.

'Yay! Oh, my gosh. May. It went down there,' said Chelsea.

'It is down there. And if you got to match the events that happened.' Steve quickly turned to Chelsea, as he was being called away by other students.

'We are trying to look for this here. It keeps opening and not opening,' said Dominic, signalling to another schoolteacher, Jason, as he happened to be nearby.

'Which event are you looking for?' Jason asked.

'May 1940, because we are trying to look for reliability in his manifesto when he became Prime Minister,' Chelsea quickly answered with frustration in her tone while holding her clipboard.

'It is May 1940,' Jason asserted, looking down at the digital file and pointing at the particular event date in the file.

'Yeah, we are trying to open it,' Chelsea impatiently moaned.

‘Okay, May 1940. You can probably get it down here.’ Jason pointed to the 1940s.

‘It is somewhere down there,’ Chelsea said as Dominic tried to open the digital file again.

‘Yeah, that is when they were in Italy.’ Jason pointed out another file and got called away by a student from another group. He walked away as Chelsea continued looking at the file.

‘I can’t use this,’ she said. ‘Let’s see, Mussolini, you could say that it shows reliability because he was helping his country, really.’

‘Helped defend a country,’ Dominic repeated while trying to help Chelsea open another file.

‘Defend, yeah, defended country. When was that? September 1940. Should we move, because this thing is not helping, because it is not opening properly. It is doing it by itself now. Let’s look for more. Oh, look. How do you, do you touch it or something? That is very cool. American relations with Roosevelt. I think that was when the Depression and everything was. Yeah. After, it was the aftermath of it, because I remember 1930, Roosevelt,’ Chelsea said as she opened the other files and tried to read them.

‘So, Stalin,’ Dominic said quickly.

‘That shows he was a nice person,’ she replied.

‘Uh-huh,’ he agreed.

Multimodal data

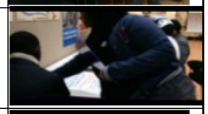
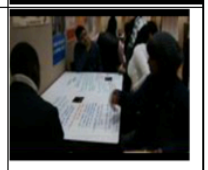
Group D Students: Chelsea (C), Dominic (D), Steve (S), Sandra, and Jason (J)					
Time	**Participant**	**Facial Expression, Gesture & Body Movement**	**Language & Sound**	**Museum Educator's Responses/Timeline Table responses**	**Still Image of the Moment**
5.23	Sandra, Chelsea, and Dominic	D has his head down, as he is texting on his mobile phone underneath the table. C faces the museum educator. Sandra looks at all the students and points at the posters occasionally.		Sandra begins to explain about the museum and briefs them about activity in which they are going to partake.	
7.01	Chelsea and Dominic	C turns around to D, then turns back and smiles at Sandra.		Sandra begins to explain about the museum and briefs them about activity in which they are going to partake.	
7.15	Chelsea and Dominic	C begins to write ideas down on the whiteboard. C makes further assertions as she circles the word with a line drawing of a cloud. D looks at what C writes down while texting underneath the table.	C: You have to be reliable. D: Definitely, confident. Because confidence, it's a bit because you have be confident in what you are choosing about.		
8.01	Chelsea and Dominic	C carries on writing. D stops texting, nods his head, and looks up to see C's writing.	C: And being confident means you are a good speaker. I think confident and reliable. Confident is a root of most of it. D: Reliable. C: Confident in the... D: It has all of these things in it. C: Yeah. D: Because without confidence, you can't speak to anyone.		
8.05	Chelsea and Dominic	C looks at D when she is speaking. She then looks down to write the word 'moral' on the whiteboard. D pauses in his texting.	C: And morals, yeah, society will affect your morals, you know what I mean, because you would be different than everyone else. D: Confident, yeah, and so brave, being brave is also courageous-minded.		
			C: Yeah, confident, yeah, and being reliable makes you, like, for the people, and it makes you willing to share ideas.		

Table 5: Sample of the multimodal script for Group D

The multimodal data (Table 5, see Appendix E for full transcript) are derived from the three chronological episodes of Chelsea and Dominic's interaction with the museum activity, Lifeline, and their schoolteachers. The three episodes as a whole illustrate a gradual progression of the two students' engagement with the museum activity, then relating and matching this topic with the digital resources, the authentic physical exhibited material, the textual information provided by the museum, and discussion with other students. This particular scenario illustrates the technical difficulty that the students encountered in using the Lifeline and their attempts to resolve it with their teachers and carry on with the rest of the activity.

The data here show a constant question-and-answer between the two students based around the activity—finding artefacts emblematic of the characteristics of a strong leader in the digital room. In this case, the students decided to search for ‘confident’ and ‘reliable’. Their utterances suggest that both understood the purpose of their visit, which enabled them to create their own context and analyse their opinions later on when they encountered the museum exhibits and the Lifeline. The technology and the museum exhibits in the digital room were seen as different representational resources for the students to explore in forming their own accounts.

This reflects Griffin and Symington’s (1998) early finding that learning processes in a museum are based on a social context. They state that in order to enable learning, students have to know what, why, and how they are gathering information, with a certain amount of freedom or choice allowed in the more detailed aspects of their learning. They stress that ownership is another important factor in encouraging them to share and collaborate with their peer group. This was borne out in most of the students’ cases; in this scenario, ownership takes the form of the characteristics the students chose, with a resulting sense of teamwork between the two. For example, Chelsea used the plural form in her utterances, such as ‘we are trying to’ when the schoolteacher asked what they were doing and ‘we need you’ when she tried to get the device to work.

Digital technology such as the Lifeline provided a sharing platform for the students. As seen in the scenario, a technical problem forced the students to be more vocal about what they were reading and interacting with amongst

themselves and with their teachers. For instance, Chelsea became more vocal in terms of how she played with and responded to the device. This 'speak out loud' process allowed the two students to be more comfortable and connected with each other's thought processes when faced with open-ended questions. As one museum educator, Flora, said:

> Part of the session is to have a broader focus of the questions, so they can pick and choose at the museum they want, rather than looking at Churchill as the war leader but his kind of life and career . . . students like to give the presentation and vocalise things. That's why we are trying to make things more optional, and group work.

She discussed the flexibility of the activity's aims and how the broader focus of the activity questions allow students to elaborate on their own accounts as well as have more control over what they are looking for in the museum, which gives them the freedom to decide on their own learning methods and materials. Steve, one of the schoolteachers, agreed:

> [The activity] was good, because it provided them with a good focus. I think the conventional way of doing this is a sheet with a series of questions on, like what date Churchill did this and what year did he do that. But this was good, because I like the way they're being encouraged in this way. I guess it made them

> appreciate and go beyond the simple headline of ‘Churchill’. So they realised that, to some extent, he was a great war leader, to others, he was a bad domestic Prime Minister, or whatever. So I think it was good they encourage them to look at different elements of his personality.

He felt that the openness of this approach allowed his students to look at the subject from a more critical and objective perspective whilst they walked around the museum. This can be seen in the scenario when Chelsea interacted with another digital device and began talking about Churchill’s relations with Roosevelt. Dominic commented on what he remembered—Stalin—and Chelsea further discussed the issue, noting, ‘This shows he was a nice person,’ and, ‘He went all the way to Moscow to clear up an understanding, misunderstanding.’

The combination of viewing the exhibit and interacting with the digital devices together with their schoolteachers provided the students with another level of social interaction, as it provided a commonly shared topic and space. Consider the incident in which Chelsea and Dominic discussed the ‘Churchill dog’ with Steve, who turned the conversation to the Internet and insurance. As with Group B at the Natural History Museum, Steve imposed his personal experience in relation to their question based on his perception of his students’ interests, which eased the authoritative role of the teacher in relation to the students.

Even though Chelsea and Dominic's questions to Steve were not related to the activity, nor to the topic of the museum, the process of asking questions about the name 'Churchill' motivated the students to further explore similar subject areas—a clear example of the *need for cognition* (Cohen *et al.*, 1995). Students are naturally inclined to engage with and enjoy thinking in an environment such as the Churchill Museum, and this engagement makes them more at ease with their unfamiliar surroundings. This can be seen later on in the scenario as the students became more active in pursuing their teacher when encountering problems or questions, such as asking Steve and Jason about Churchill's becoming Prime Minister in 1940. The role of the technology here was to act as more of a reassurance resource for the schoolteachers when faced with detailed questions at a time when there were no museum educators around. Of note here are the findings of Paris *et al*. (1998) and Griffin (2004), who concluded that a shared interest in a topic, such as this museum activity, can provide both parties with positive value-related characteristics that inform their approaches to engaging with the tasks chosen.

6.3 Group E

Interaction with the Lifeline



Figure J: Photograph of students' interactions in the digital room in the Churchill Museum, London ® Ariel Liu

The photograph (Figure J) shows Kate and Hannah visiting the digital room after the activity briefing by the museum educator. This illustrates the moment when Hannah discovered the Lifeline and learned that Churchill travelled to numerous countries, which will be mentioned in the scenario. The photograph shows how she held her clipboard with one hand and tried to navigate the table with the other, while explaining her actions to Kate. Like Group D, the students spent more time browsing and selecting relevant information that they needed for their activity. The lack of light resources in the digital room meant that the students paid more attention to the screen or the lit

exhibits. The two students used this particular device as their main resource for their museum activity task.

Scenario

Hannah and Kate were asked to be in a group for the museum activity. During their time in the learning centre, they decided to choose ‘confident’ and ‘responsible’ as their characteristics of a strong leader. As they entered the digital room, they noticed Churchill’s long black coat displayed in a glass cabinet at the entrance of the room. Hannah turned to Kate and asked, ‘Is this the coat he wore?

‘Worn by Churchill at the siege of Sydney,’ Kate read, looking down at the label.

‘Is that the real coat?’ Hannah asked, clearly surprised.

‘Oh, well, they might do a replica of it. Well, he is responsible because he kept his coat clean.’ Hannah walked toward the label and looked closely at the coat, then turned to Kate. She then looked down to her clipboard and began to write as she spelled out slowly, ‘He-was-in-charge-major-events. So he was in charge of major events. People, so people had relied on him.’

‘Yeah,’ Kate agreed.

Hannah passed her clipboard to Kate, and as Kate received it, Hannah explained, ‘I can’t spell. Oh, yeah, sorry, I forgot you are left-handed.’

‘Maybe some people didn't like agreeing with him. Like, he was responsible even though like people didn’t agree with him and stuff, didn't agree,’ Hannah continued as she went through the wooden files in the box. Kate carried on writing.

‘Ah, I don’t like him,’ said Hannah as she pulled up one of the wooden panels on Chamberlain.

The two students walked toward a touchscreen device, which appeared to have some animation. ‘Okay, that is gorgeous. Touch screen to start,’ Hannah read, looking at the screen. ‘So wow, he wrote a lot. He went, oh, no. He was from France, oh, he was in like in charge of giving out bad news and stuff and so.’

‘Uh-huh. Was he?’ Kate asked.

‘Yeah, because if something bad happened, he would have to tell everyone.’ Hannah faced the screen as she justified her statement.

‘In charge of giving warnings.’ Kate slowly spoke as she wrote it down on her clipboard.

‘Yeah.’ Hannah looked around at the other exhibits.

Kate paused. ‘Wait, in charge of what?’ she asked.

‘Like, in charge of giving warnings,’ Hannah explained, turning to Kate.

Hannah walked toward another textual panel and read for a few seconds. She turned to Kate with confidence and said, ‘Okay, right, like he had to work, like, ten times harder than anyone else, if you think about it.’

‘He was very important,’ Kate agreed.

‘Yeah, you can write that down, basically,’ Hannah stated.

‘He was very important,’ Kate wrote down as she read out loud again and asked, ‘What was the largest?’

‘I don't know.’ Hannah shook her head. She paused and slowly said, ‘Very important—can’t think of anything.’

‘Very important, oh wait, let's go over here, it's like a video.’ Kate began to look around, and turned toward the Lifeline.

‘Oh, my God, that is so cool. Wow-oh, look at that. Oh, you click it. So, June 1940. Okay, so Churchill again files, or flies, to France for crises, talks to French for—oh, he had to travel around. He had to travel quite a lot, and so.’ Hannah was puzzled as she tried to touch the projected table surface. She then realised that the device would only work by scrolling the bar.

Kate was trying to scroll the bar while expressing her thoughts out loud: ‘I don’t even get it. Oh, I think that would be even better.’

‘Oh, wait, we could do about September. No, wait, maybe later, like a later kind of (.) I want to, like, December!’ Hannah shouted as she was scrolling and browsing. After a few minutes, Hannah paused and exclaimed with a smile, ‘Oh, wait, here we go, that is my mum's birthday!’ She continued reading out the texts from the screen: ‘Churchill writes Lieutenant Commander Brickford, Captain of the submarine HMS *Summer*, to launch. He was to hear how Brickford torpedoed and seriously damaged two German cruisers early in the war, giving a major boost to public something, I don’t know, I couldn’t finish it. That is so cool.’

Kate tried to read out what Hannah had found as she murmured the same text.

Hannah continued browsing the files until she found the October file and said, ‘Oh, October, here we go.’

Kate then had an idea. ‘What happened on my birthday?’ she asked. ‘They don’t have the 10th? Nothing must have happened on the 10th, okay. On

this day—' She found the month but was disappointed by the result.

Both of them continued reading and browsing through the digital files from the Lifeline. Suddenly, Hannah found a file, while the reward effect (see Section 4.2 for more detail) was triggered by another student on the other side of the table. Hannah, taken aback, asked, 'Oh look, what did you do?' The effect disappeared within a few seconds, and she continued. 'So what happened on the May 18th, so Churchill follows worsening news. He, like, gave bad news to not just England, but like other places, like France and stuff.'

'Reliable for updating news,' Kate replied.

'Yeah,' Hannah agreed.

'Look at this! The effect is so cool.' Kate leaned against the table and continued reading different files until she found one in which a photograph of Churchill with a politician appeared.

'That is quite cool. I wonder what happened over here?' Hannah smiled and tried to open another file.

'It has video!' Kate quickly replied.

'Does it? Fabulous. Churchill was working in bed, the first thing he did was—no, no, no, I'm not done yet!' Hannah exclaimed as her file automatically closed while she was trying to copy information down onto her clipboard. As the digital file closed, she went back to the same folder and file as Kate.

'No, no, look at that one, is it this one?' Kate tried to help out.

'Okay. Churchill was first working in bed for the first Sea Lord Dudley,

telephones him about sinking the Japanese aircraft carriers as well—' Hannah found the file and continued writing as she murmured out loud what she was reading. 'Many have died,' she said as she finished the last sentence.

While Kate was trying to explain to another student what they were doing, her file closed. She yelled at the device, 'Wait! I was reading that!' She then turned to another student, 'It was 1937, it was 1937, it was September.'

Hannah turned to Kate, 'Oh, I just wrote that.'

'You don't write, I am just reading it.' Kate said.

'Should we move on to over here? Look at how many there are. August 1950, this is right after the war. Churchill had repeatedly requested the Prime Minister—became Prime Minister.' Hannah walked further down the table and found another digital file as she spoke out loud. She continued slowly as she wrote on her clipboard against the table. 'Became, decided to be Prime Minister again. He must have quite liked being Prime Minister and liked the responsibility, because he decided to do it again after the war.'

'Yeah,' Kate agreed, watching as the museum educator shouted out to all the students, 'Five minutes left, everybody, five minutes left!' Both of them turned their heads up towards her and Kate sighed, 'Oh no.'

'Yeah. Liked having—yeah, wow.' Hannah expressed her interest in another video she had found in the digital file.

'Check this out,' called Kate.

'I did it again, no, I didn't. Responsibility.' Hannah paused and wrote.

'Okay, let's go over here. He must have been responsible.' Kate stumbled towards the glass cabinet that stored Churchill's medals.

‘He must have been. Oh, look, Belgium.’ Hannah pointed at one of the medals.

‘What are all of these awards?’ Kate asked.

‘Wow, he got a lot,’ Hannah said as both of them began to write on their clipboards.

‘This shows confident as well, look at all the crosses,’ Kate said as she wrote. She turned to Hannah and said, ‘Write it down as well. These are all, like, real important.’

‘He took care of his treasures. It is a quite honourable thing.’ Hannah replied.

‘Don't write anything about sirens,’ Kate said.

‘Took care of his clothes,’ Hannah wrote as she read out.

‘Hannah, there is something here, look.’ Kate pointed at an image on a screen.

‘What?’ Hannah asked, turning toward it.

‘He made even more stuff after the war,’ Kate said.

‘Huh? He drove himself even harder!’ Hannah exclaimed, and wrote.

‘He worked very hard during the war,’ Kate emphasised as she leaned against a platform.

Hannah continued writing and talking aloud. ‘During the war.’

Multimodal data

Multimodal Transcript
Group E Students: Hannah (H) and Kate (K)

Time	Participant	Facial Expression, Gesture & Body Movement	Language & Sound	Exhibit or Timeline Table responses	Still Image of the Moment
3.05	Hannah and Kate	Hannah walks around the glass cabinet. Kate holds the clip board and reads the labels after Hannah mentions the glass cabinet with a coat.	H: Is this the coat he wore? K: Worn by Churchill at the siege of Sydney – H: Is that the real coat? K: Oh, well they might do a replica of it. Well, he is responsible because he kept his coat clean.	Churchill's Coat	
3.58	Hannah and Kate	Hannah looks down to the label with Kate. She reads out the label slowly and starts writing information onto her clipboad. Hannah passes her clipboard to Kate.	H: He was in charge major events. So he was in charge of major events. People, so people had relied on him, yeah. K: Yeah. H: I can't spell. Oh, yeah, sorry, I forgot you are left handed.		
5.11	Hannah and Kate	Kate leans against a station to write down what Hannah suggests. Hannah starts pulling up the wooden boards from the wooden box one by one to read what is on each board.	H: Maybe some people didn't like agreeing with him. K: Some? H: Didn't agree. H: Like he was responsible even though like people didn't agree with him and stuff, didn't agree.	Wooden box with many small wooden boards with different leader's profile.	
6.22	Hannah and Kate	Hannah pulls out wooden panels from a wooden box.While Kate writes on her clipboard. Hannah then turns towards a textual panel while Kate tries to speed up writing.	H: Ah, I don't like him. H: Okay, that is gorgeous. Touch screen to start. H: So wow, he wrote a lot. He went, oh, no. He was from France, oh, he was in like in charge of giving out bad news and stuff and so. K: Uh-huh. Was he? H: Yeah, because if something bad happened, he would have to tell everyone.	same as above	

Table 6. Sample of the multimodal script for Group E

The multimodal data (Table 6, see Appendix F for full transcript) show an episode of Hannah and Kate's interactions in the digital room. It depicts the two students' interactions with some of the authentic exhibits and the Lifeline in the course of their investigation of Churchill's life. The Lifeline was, in particular, the focus of this discussion, and these students' interactions and behaviour were very similar to many other cases in this study.

The data show that the interaction was a constant 'talk out loud' question-and-answer between the two students. During this exchange, they did not turn to or face each other, yet their communication was still achieved. What the exhibits and particulars of the Lifeline provided was an initial

attraction that allowed the students to vocalise their personal observations and share their opinions and experiences.

In a way, it can be suggested that the process of navigating the digital material of the Lifeline provided students the time and space to read while reconstructing their thoughts and information acquisition physically as well as mentally. As discussed above, Leinhardt and Crowley (2002, p.306) observe that in learning at museums, knowledge is derived when 'small clusters of individuals engage with objects' and takes the 'form of conversations'. On many occasions, the two students had to physically navigate and look for their resources, such as video or textual materials. By working together, they uncovered the resources they sought. In another way, the digital cabinet file presentation and physical browsing file function of the Lifeline inspired them to relate events to their personal life and experience. For example, Kate asked, 'What happened on my birthday? They don't have the 10th? Nothing must have happened on the 10th, okay.' Because the table contains significant dates from Churchill's long life, many students wanted to find out what kind of historical event happened on their birthday. This is a detailed example of a recurring pattern that many students encountered with museum exhibits in general during their visit, but with multimodal technologies in particular.

Through this interaction with the multimodal technologies, the students were able to further connect with the other contents of the exhibits. For instance, after their interaction with the Lifeline, Kate suggested pressing on to another device while expressing her belief that there must be related content in other devices or exhibits. Later, they found the medal cabinet, and

Kate stated, ‘This shows confident as well . . . these are all real important.’ This was further discussed and confirmed by Hannah: ‘He took care of his treasures. It is a quite honourable thing.’ Put simply, this type of interaction is a reciprocal visual and physical observation-building exercise between the students, through various representations from the technological devices and exhibits, followed by personal interpretation, discussion, and even conclusion. Arguably, it is a process of unsound guesswork and presumption constructed around randomly selected artefacts. This is not meant as a direct criticism of the museum curators or educators, but as a disinterested observation on the activity that the students were asked to undertake. It is important to be aware that the students were not familiar with the context, and could benefit immeasurably from having some general background knowledge prior to their visit.

Individuals’ ‘active discovery’ is key in enabling their interaction with the exhibits, and the technologies here provide an approachable arrangement that sustains visitors’ interest, which can be physical as well as visual. On a related note, the ‘fun’ element provided by a museum is an essential factor, but its importance has not been fully justified or rationalised in relation to students’ museum visits. As Osborne (1998, p.9) explains, the ‘highly enjoyable’ factor can encourage visitors to focus and recapitulate the content of museum exhibits. In this study, fun is a crucial influence that cannot be dismissed. In this case, for instance, many of the initial observations or engagements began with a personal connection with enjoyment and sharing this enjoyment with others. Expressions of excitement and approval were

sustained throughout the students' physical interactions and mental engagement with the contents of the museum, and in most cases, it was the multimodal technologies (aural, visual, and physical effects) in combination with the authentic displays of text that supported their understanding.

According to the museum designers, another factor working in tandem with the 'fun' factor was the reward system. For example, when a visitor triggers a famous date, five seconds of animation will appear on the entire table, and other visitors cannot interact with the Lifeline until the animation is finished (see Section 4.2 for more detail). In this scenario, the two students' reaction was slight puzzlement about the function of the device when an animation was triggered. But as the museum designer mentioned, the intention is to provoke social interaction and interest in finding out how it is triggered. Indeed, the two students tried to figure out whether their choice of file was related to the reaction. On finding that it was not triggered by them, they carried on with their own exploration.

This 'fun' element was therefore questioned when students encountered its educational value. Moreover, not everyone was keen on the reward system, such as museum educator Flora:

> And for me the rewards are obviously interesting, but I am not quite sure what the point of them is, if the point of the table is to put a lot of Churchill's life into context. I would like to know and don't really know the idea of what the reward system of the Lifeline is for because there is still a confusion about what it is

> for. Is it something gimmicky for people to play with or is it something used as a tool to find lots and lots of different things? That's how we use it personally when I want to find out some information.

She questioned the importance and function of the reward system, as she considered its appeal to be 'gimmicky' and less constructive in terms of building students' understanding of Churchill's life. This, however, may refer back to the general function of the museum as a place enabling 'people to explore collections for inspiration, learning and enjoyment' (Museum Association, 1998). Therefore, the 'gimmicky' element may be interpreted as an alternative learning method to enhance visitors' motivation and inspiration. Arguably, this also heightens the importance of establishing more transparency between the museum designer, educator, and schoolteachers in preventing misunderstandings as well as fostering better conveyance of information for the students.

Although relatively few schoolteachers referred directly to this reward system in this study, the entertainment value of the museum was an initial consideration for them, as expressed by one schoolteacher, Steve:

> Obviously there is the political element linked in with our course, but I wanted them to experience a modern museum with interactive features and technologies. I was pleased with how [the students] responded. The way the museum is set up

> encouraged this sense of discovery. It doesn't make people walk around in a certain way. There is different things for different people, for instance there is video to watch, the Lifeline to play with and some artefacts to look at as well. There is a range of learning styles that is catered for.

Steve indicated that the entertainment value of the museum could be helpful in assisting his students to be more interested in the exhibits and resources. A multimodal museum could be used to inspire his students to discover information outside their school curriculum that the school might not be able to provide.

The task given by the museum activity was another key factor in determining the students' interactions. As the multimodal data show, the students constantly wrote on their clipboards, talking while writing as they examined the museum's exhibits. Moreover, there was an animated discussion on the chosen topic in each group. Each group of students could choose a topic of shared interest when visiting the digital room. This social context reinforced their decisions in their engagement with certain exhibits and their meaning-making process. As previously mentioned, studies (Grinter *et al.*, 2002; Heath *et al.*, 2002; Meisner *et al.*, 2007) suggest that group experiences reinforce individuals' thinking and learning in museums. Most of all, they improve students' understanding, as the students have to choose and connect with certain topics and information. Museum educator Flora emphasised:

> [T]he overall skill that you can take away is how to select information from a museum. And obviously secondary to that is to find out more about Churchill. And then also seeing how learning about the historical figure is relevant to your everyday life.

She explained the different levels of intention behind the activities and the museum's goal: to train students to research and select suitable information, but also to discover a historical figure's life and achievement. To some extent, in most of the cases, particularly the three scenarios in this chapter, the students managed to meet this goal, but in this particular case, it may not be as directly apparent; Kate and Hannah tried to relate their or their mother's birthday to the date of historical events. In a sense, it could be suggested that they tried to connect the found information and the exhibit with their personal experience in a trivial way.

6.4 Group F

Interactions with different sensory devices, peer group, and museum activity



Figure K: Three photographs of students' interactions in three locations, Churchill Museum, London ® Ariel Liu

Figure K consists of three photographs of three different locations in the Churchill Museum. The chosen images portray a sequence as four students, Ellie, Laura, David, and Peter, worked as a group during their

museum activity in the digital room. The first photograph demonstrates how the students congregated around the textual panels; Laura was the leader of the group, guiding and dominating most of its discussion. The other three students generally acted as listeners or note-takers during the activity, though in some places they contributed comments and personal suggestions. This happened quite frequently when students were asked to be in a group of more than three people. In this case, the students visited the same digital room as the rest of the schools, but spent more time reading textual material on the panels and finding the relevant resources they needed for their activity. As in the previous two scenarios, the dim light, multiple platform-like stalls, and the separation of the space created by the textual panels made the atmosphere of the room more intimate, personal, and casual. The students were less rigid in terms of their standing pose, particularly Laura, who leaned against one of the platforms as they discussed the museum activity.

The second photograph illustrates how halfway through the activity the group was somehow separated into two groups (two girls and two boys). The two girls in the photograph decided to check out the telescope devices, which show a black-and-white vintage film of a sea operation. The third photograph shows the four students congregating in front of the textual panel discussing and sharing their findings together.

Scenario

The four students were asked to be in a group for the museum activity. They chose ‘decisive’ as a characteristic as a strong leader. As they entered the digital room, they began by reading the first textual panel on Churchill’s

wartime career from 1940 to 1945, starting when he was elevated to the role of Prime Minister and concluding with the end of the war. Laura held a ruler that she took from the learning centre, then pointed at the panel and faced the others as they started forming a circle around the panel. ‘Guys, guys,’ she began, ‘if you read it over here, it says that he became a symbol of what strong leadership should be when he nearly got defeated, but made it in doing so. And so that was basically saying that he was a strong leader, because he nearly, they nearly got defeated but they didn’t.’

‘This was in…’ Ellie headed down and started to write some notes on her clipboard.

‘This was the Second World War,’ said Peter, finishing her sentence.

‘Yeah, so?’ Ellie continued as she looked up.

‘So, we could say that he followed through, he probably followed through with decisions he made nearly, decisions he made to then become known as a strong leader,’ Laura answered.

‘And nearly got defeated, but…’ David quickly replied.

‘So just say he followed through with the decisions. Yeah, because he led them from near defeat to final victory, and they ended up, and then they ended up winning, and so he must have made decisions and followed through with it. So did you say it then goes from near defeat and then he managed to win?’ Laura said to David

‘Managed to win, okay,’ Ellie wrote on her clipboard as she spoke.

‘Should we walk on?’ asked Laura, then smiled and led the way. The other three followed her for a while and started to look around in different

directions and sections of the digital room.

Later, Laura called for others' attention. 'Guys, here it says that some people liked him, so he was popular, but others disliked and distrusted him. And so maybe they thought he wasn't doing what was best for the country, and that was the reason for not getting…'

'Yeah,' said Ellie, turning around.

'And so that could be a reason for not voting,' Laura added as she looked at Peter and David.

'He was opposed a little bit,' Ellie said as she looked up.

'Yeah, so, like, he didn't, they didn't trust him to make the decisions,' Laura emphasised.

'Yeah,' Ellie nodded.

'And so maybe that would be a reason why he wasn't very decisive.' Laura turned to Peter and David again as they both looked down at their clipboard to write notes.

The four of them moved down to another panel with some authentic exhibits of a Morse Code device and some digital screens showing how it was used at the time. The two girls read the text while the two boys turned to the other side to look at the uniforms that Churchill wore. Ellie turned to the boys and said, 'That was very good, because he insisted on seeing how the war was fought.'

'Yeah, he checked out new technology so that they could stay in the war,' Laura added as she continued reading.

'Yeah, so that was, like, that was a good decision to make. Yeah, that

was good, because he thought it was best to lay a bold attack instead of a defence. And so then, but then he didn't, he wanted to avoid a mass slaughter, also, and so he didn't want to kill those people. But, so he obviously made a good decision there, because then it led them to win the war,' Ellie concluded as the boys walked toward them. She then suggested, 'Should we walk down here? There's that thing.'

Peter turned to David and said, 'So, let's look at the Lifeline, look at the Lifeline.'

Meanwhile, Ellie said to Laura, 'Oh, there is Morse Code there.'

Peter and David then went on to the glass cabinet where Churchill's clothing was displayed. Peter laughed as he looked at the pyjamas that Churchill wore as he read the label for the cabinet: 'He was the only Prime Minister to wear military outfits. Hahaha…'

David laughed and exclaimed, 'Hahaha, I am liking the pyjamas.'

Peter pointed and replied, 'Look at his pyjamas. Oh, my God, it's legendary!'

The two girls went on to the telescope device. Laura, at one telescope, asked Ellie, 'What's yours?' as Ellie yelled, 'Laura, go in there, you can see the inside things, look inside it, you can see like, look! So, like, water blowing up. What's yours?' Ellie added as she continued looking into the device.

'Basically,' Laura slowly replied with hesitation.

'With two men on the side,' Ellie described.

'It is a tank and it is firing. No, it is kind of showing something—one side is showing it going under the sea, something like a field gun at the sea,

and the other one is a tank. And yours looks like everything is blowing up and that there is like an animal running. No, that is just…' Laura explained as she looked up and turned to Ellie.

'Yeah, I know, you can go to different places. That is so cool. Now it's going over the sea and it's showing a tank on that left side,' Ellie replied, excited.

'Yeah, so I'm back in the tank now. This is so cool. Oh, it's just showing everything blowing up and then going into the sea, description, rocket propelled, high explosives. Purpose: designed to destroy enemy coastal defences. First used: project abandoned after test in 1944.' Laura stopped and started reading the textual panel next to the device, which labelled the purpose of the video.

'Which one are you on?' Ellie asked.

'I am on the, it is in the sea and it's got, there's nothing going through it. And the men are walking through the snow. And then now it's showing Churchill standing there with his men, and they've all got their things ready to fire, cannons or what,' Laura replied.

'And mine is like…' Ellie tried to describe.

'Listen to this. Defence factories. Description: rocket projectors. Oh, they are rocket projectors to destroy—purpose: to destroy enemy aircraft. First used in the United Kingdom in 1943, but unsuccessful. Okay, well, this was a bad idea. You could write this was a bad idea, because he used these things as defence factories, which fire rockets into the sky to kill, to destroy aircraft. But it said it was unsuccessful. And so you could say that he made a

mistake with the military equipment.' Laura cut off Ellie's sightline as she pointed to the label.

'It's on the screen.' Ellie pointed at the other digital screen, which had the relevant information. She then wrote notes on her clipboard.

'And basically, no, it doesn't have it on the screen. I will show it to you, it is, okay, well, they will come in a minute. These things, okay, factories, read it now.' Laura pointed at the screen as the text appeared.

'Unsuccessful,' Ellie read out, and wrote on her clipboard.

'Yes, so they were defence factories, which were designed to fire into the sky to destroy aircraft. And they were unsuccessful. They were to fire into the sky to destroy aircraft. Okay, where shall we go?' Laura walked forward to the other section of the museum as Ellie followed.

Later, they stopped at the Lifeline. Laura scrolled around the digital file and stopped. 'Wait, Churchill was very quick through his political roles. He didn't really fit into the political party. Within five years of arriving in Parliament, he became government minister. He made some enemies and changed his party twice.'

Laura continued as Peter and David walked toward them, 'I think we could take a picture of that, because it is showing how, you know, it is showing how he didn't stick to his guns, he didn't like—this shows how he changed his political parties twice, and so he had made a lot of enemies. And so he is kind of showing he wasn't decisive in his ideas, and kind of a bit of like a traitor, he's going from party to party.'

'Also, we looked over there and we found that he joined the army very

young. Then he cut it all to be a politician.' David pointed his right hand at the other museum exhibits, then further explained, 'And so it is kind of saying that if he wasn't doing then, he would be that.'

Laura then said, 'He didn't follow through in his decisions. Yeah, so, should we get the camera and take a picture of that?'

Ellie replied, 'Yeah and then we need to find it as well.'

'He chose to give up his position as assigned for the front lines in France in 1915,' Peter read from one of the nearby textual panels to get the others' attention.

'No, he's made some really good decisions, but then he's also, like, just hasn't stuck to his guns on some things, so he just moved from two different parties,' Laura argued. 'Look, Ellie, here, it says there were military and political indecisions and the compromise model meant that thousands of Allied troops were to die in a hopeless situation. So because he was indecisive and so it led a lot of people to die,' she read on another digital screen. 'And this is what Peter was saying. Yeah, because he was, he became a soldier and then he just kind of gave up it all up to become a politician. And so he just gave it all up to become a politician, and so he didn't, he wasn't strong with his decision deciding what he wanted to be. He didn't pursue that career, he just changed it. The board over there.' Laura pointed at the screen for Ellie while looking at Peter's expression.

Multimodal data

Multimodal Transcript Group F Students: Peter (P), David (D), Ellie (E), and Laura (L)					
Time	**Participant**	**Facial Expression, Gesture & Body Movement**	**Language & Sound**	**Exhibit that the Students Encountered**	**Still Image of the Moment**
23:25	Peter, David, Ellie, and Laura	All begin to read the textual panel. L holds a ruler pointing at the screen while two of them write notes down and one of them reads the wall text as she summarises it.	L: Guys, guys, if you read it over here, it says that he became a symbol of what strong leadership should be when he nearly got defeated, but made it in, in doing so. And so that was basically saying that he was a strong leader, because he nearly, they nearly got defeated but they didn't. E: This was in – P: This was the Second World War. E: Yeah, so – L: So, we could say that he followed through, he probably followed through with decisions he made nearly, decisions he made to then become known as a strong leader.	Textual Panel on Churchill's 1940-1945 wartime career. It contains one illustration and four paragraphs of textual information.	
24.01	Peter, David, Ellie, and Laura	D, E, and P are looking at the exhibited object while L reads the other textual panel.	D: And nearly got defeated, but – L: So just say he followed through with the decisions. Yeah, because he led them from near defeat to final victory, and they ended up, and then they ended up winning, and so he must have made decisions and followed through with it. So did you say it then goes from near defeat and then he managed to win. E: Managed to win, okay. L: Should we walk on? D: All of them, he's got a cigar in his mouth. Apart from that and that. P: I know, no, no, oh no, he's got one there.	D, E, and P are looking at the glass cabinet that contains a series of ceramic models and sculptures of Churchill. L is reading a projected text on another panel of quotations on how people perceive Churchill's war role.	

Table 7: Sample of the multimodal script for Group F

The multimodal data (Table 7, see Appendix G for full transcript) are derived from three episodes of Laura, Ellie, David, and Peter's group interaction in the digital room. The data illustrate how the four students sought out the characteristic 'decisive' through their investigation of Churchill's life and their interaction with all the exhibits and technological devices in the digital room. This scenario describes the ways in which they began by reading textual panels as a group with one leader, Laura, interpreting the exhibit content. Halfway through the activity, the group gradually separated into two groups, and toward the end of their visit, they got back together to discuss their findings.

The utterances from the multimodal data indicate that the students, especially Laura and Ellie, focused most of their attention on the subject of 'decisive' in their interactions with the museum exhibits. This subject matter drove the students to look at aspects of Churchill's life through various representations, such as textual panels and digital technologies. This was then interpreted through their personal opinions; for instance, toward the end of their visit, David pointed out information about Churchill's army career from one digital source, and Peter followed it up with information from a textual panel. Much like the two previous groups, however, this group's personal opinions, interspersed with the random selection of artefacts, led to unwise and inaccurate interpretations that lack any serious foundation in historical or political awareness. For instance, Laura's ill-informed speculation on the rocket projectors might lead to further misunderstanding if it was unaccompanied by any correction from a museum educator or schoolteacher. Still, this study is not intended to evaluate the rights and wrongs of the interaction and outcome, but to determine how the exhibits and devices provoke certain behaviour and understanding, given the students' lack of basic contextual prior information.

The data also show that the students were able to utilise the resources from the technologies and panels to assist them in the activity and to help them understanding Churchill's life and achievements. This can be seen from the poster they made after the activity (see Figure L), which contains several small pieces of information on different aspects of his personal achievements that they collected while using the devices and reading the textual panels and

labels. The red writing is what they believe to be the pros, such as ‘Churchill nearly got defeated but followed through with his decisions which led him to victory,’ and the green writing is the cons, such as ‘Joined the army at a young age but gave up to become a politician.’ The dark blue writing that is in a box contains the students’ conclusion:

> Over all we thought Churchill *was* a decisive leader because he made a lot of right decisions in military and tactical methods for war and did what was best for his country. However he gained a lot of enemies in the process due to poor decision-making and didn’t stick to his guns.

Their written conclusion and ideas in the poster reflected the conversation in the scenario. The poster also demonstrated a constructive meaning-making process and showed how the students observed and interacted with the technological devices, exhibits, and authentic objects, in addition to their group decisions, criticism, opinions, and experiences. This echoes many early researchers’ (*e.g.*, Julyan and Duckworth, (1996); Cox-Petersen *et al.*, (2003)) discussions, as they found that in order to construct students’ understanding, a museum must provide opportunities for students to verbalise their thoughts and ideas through conversation with their peer group, forging connections between the exhibit and their personal experiences.

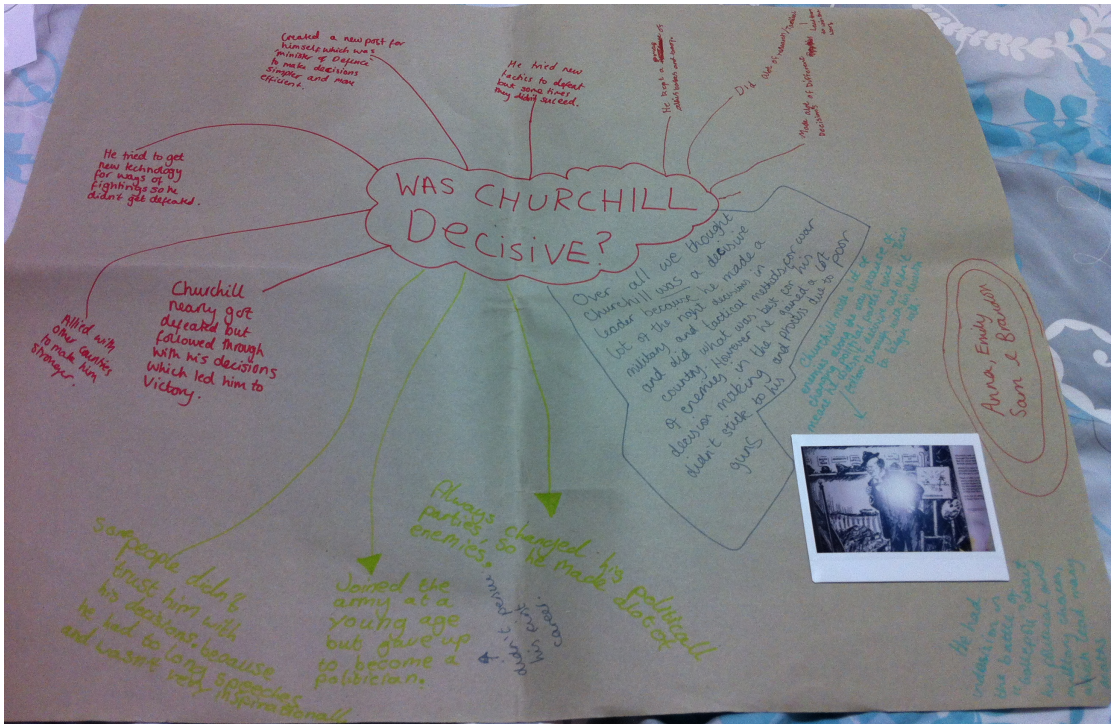


Figure L: Poster produced by Group F

The role of the technologies here is similar to that of the textual panels, as the students spent more time with the text. In addition, however, the technology provided alternative representations of the text and allowed the students to perceive information in a different context. For instance, due to the single-user nature of the devices, the students had to be more vocal when they interacted with a device and shared the experience with their peer group, such as when Laura and Ellie encountered the telescope device. To this end, they would have to select relevant information individually and through various devices, then share and discuss as a group. This correlates with how Flora, the museum educator, described the goal of the activity and the museum's approach:

> One of the aims of the session is to see how you can use museums and select information from the museums. That is a skill that we are trying to get across. It is a skill that you need with a complex museum like that. It is overwhelming when you're going into a museum when there are too many things going on and too much information.

She asserted that visiting a museum can be overwhelming due to the complex setting and compressed textual information, especially for young visitors. Therefore, the activity is designed to guide the students in methods of information selection when visiting a museum. Indeed, the four students selected information based on their interests, such as Peter's statements about liking Morse Code and Churchill's 'legendary' pyjamas. The overwhelming effect of the exhibits and technologies may complicate what the students can grasp or comprehend during their visit, however, and so the activity was able to direct the students. As their teacher, Richard, emphasised:

> I think [the museum] can be quite overwhelming. For [the students], you kind of have to set one or two objectives for the kids, otherwise they just walk around and don't know what to do. The leadership thing [the activity] was good to keep them focused. The digital room was very good because it has all the wacky technologies that the kids can play with, and that

> definitely grabs their attention. But I think that they need more focus on what to do.

Richard reiterated Flora's point. As he observed in his students' interactions, many of them were overwhelmed by the technologies and other exhibits; nevertheless, the activity was able to sustain their interest and focus. It may be argued, however, that this task-driven activity may discourage students from spending more time in certain areas or allowing themselves to fully explore the content of the devices or textual panels, as there is a constant rush to move from one area to another. For instance, Laura rapidly guided the group through the exhibits in search of particular information. As Mandy, one of the other schoolteachers, affirmed:

> [E]ven for me, I found them quite overwhelming. And I jumped around the technology one rather than about the information. I think it's perfectly natural that the students are just playing with the interactive stuff rather than just reading the text.

Mandy commented that not every student spent time and read information from the technologies or textual panels due their lack of concentration, short attention span, and feeling of being overwhelmed by the technologies. She even found herself reacting in the same way when facing the technologies; she had to focus more on the usability of the device rather than the content.

This may be one of the factors that affects the progression of the students' physical modes as they become more at ease in interacting with the Lifeline and other hands-on technologies at the museum. They become more vocal in their interaction with the exhibits when the modes are more physical, such as the scrolling of the bar on the Lifeline, or touching the screens.

6.5 Conclusion to Part A

This chapter unveils the 'how' behind the multifaceted interactions between students and their engagement with multimodal technologies, exhibits, and their peer group in the Churchill Museum. Using the same method and analysis presentation as was used in Chapter 5, the multimodal analysis and semi-structured interview data from the museum educators and schoolteachers help answer the first operational research question. The chapter also analyses in detail the ways in which the three groups of students interacted with the Lifeline, authentic exhibits, textual panels, and the museum activity in conjunction with their physical behaviour and conversations.

This chapter will be further investigated and referred to in Chapter 6, Part B, in relation to the 'why' concerning the students' thoughts and intentions behind their actions. These two findings chapters, taken together, will in turn be reviewed and discussed in Chapter 7.

The findings from these three scenarios illustrate a micro-level of analysis of the forms of students' interactions in relation to the multimodal technologies. One cannot conclude definitively that the technology is the only influence, as the museum activity, content of the technology, and textual

panels are all crucial elements in enhancing their understanding. On a surface level, however, the provided technologies, spatial arrangements, and lighting sources derived from the screens have similarities to certain aspects of the Natural History Museum, and correspondingly, the students became more relaxed in this unfamiliar environment. In addition, what the technologies provide is an initial attraction and a shared platform to 'talk out loud' about their thoughts and actions. Furthermore, in all three cases, the museum activity induced the students to seek a shared focus (*i.e.*, leadership) and provoked them to begin a question-and-answer approach to relevant information about Churchill's life and achievements. The forms of interactions are complex and cannot be generalized, yet in the majority of cases in this study, the physical mode of 'touch' was not seen as frequently as the modes of 'talk out loud' about one's observations and thoughts, and 'read out loud' the textual material in this museum. It is these actions that formed the foundation for later conversational, social, and shared structures by which the students further related the information to their personal experiences. It also indicated some issues, such as unsound interpretation and speculation based on random facts and guesswork. This will be further discussed from the students' perspectives in the next chapter, as well as their own analysis of their behaviour and perceptions.

Part B

6.6 Introduction to Part B

This second part of Chapter 6 discusses the findings with respect to the Churchill Museum relating to the second operational research question:

> *To what extent and in what ways do these engagements result in experiences of learning?*

It also continues to explore how the interactions and scenarios previously detailed in Chapter 6, Part A enable students to relate to their learning experience, personal interests, school curricula, and knowledge developed by the museum visit. The data here are derived from semi-structured and stimulated recall interviews, conducted with the students one week after their museum visit. In addition, this chapter serves as a confirmation of as well as a reflection on Chapter 6, Part A's findings.

The section below addresses the issues arising from students' perspectives on how they construct their understanding and behaviour in a new and unfamiliar environment. It also looks at how multimodal technologies were used in relation to the ways in which the students became more familiar with the learning environment and developed interests through group activities. The results show that students were able to relate their visit to very basic concepts, but displayed disjointed relevancy in relation to their school curriculum or to interests developed during their visit. This was, however, due

to the lack of follow-up or preparation sessions in school; as a consequence, the students had difficulty sustaining their memories of the terminology or retaining information learned during the museum activity. Their physical interaction with the multi-sensory devices, on the other hand, triggered many of their memories of particular discussions and themes during their visit.

6.7 Entering an unfamiliar space

Although a museum visit is in an 'out-of-school' context for students, museums are still largely learning oriented. The students in this study showed intense interest in learning in their forms of interaction, or else they seemed to seek to learn even though they were under the compulsion to do so. For instance, in the case of Group D (see Section 6.2), Chelsea and Dominic tried to accomplish the given task at the beginning of their museum activity. Dominic spent much of the first part of the activity texting and parroting Chelsea's ideas, which is an example of 'out-of-school' behaviour in conflict with a 'learning' environment. As the activity progressed, however, he stopped texting and became more active in expressing his opinions and thoughts, especially in the digital room. In his interview, he explained:

> I didn't know where to start when I first walked into it. That's immediately confusing for me.

This sentiment was common in the students' interviews, as they found it difficult to engage with the museum and its provided context. It also draws

attention to the concern that the students had a minimal understanding of World War II and little prior knowledge about Churchill, hence their confusion. To help with the confusion, the activity encouraged students to go in a certain direction, and the technological aspects provided more comprehensive learning support. As Dominic stated:

> When I first arrived at the museum, it didn't look that interesting. But when we started the task, it was a bit more interesting and everything. The technology that they use, like the camera and the table [Lifeline], was all right. It made it [learning] a bit better.

From these two statements, it can be inferred that the overwhelming effect of the exhibits and the exploratory nature of the museum's presentation discouraged him from engaging with the museum context. Nevertheless, the task of the museum activity provided better guidance for him to focus on what he was interested in or should be learning. Similarly, David from Group F acknowledged:

> I didn't really know what I was doing, but it took me a while to get into it. I mean afterward, I got it. When I was in the museum, I just walked one way until I got back to the same point. I didn't know where I was going, but we have more freedom and do your own thing.

David illustrated his initial confusion over the purpose of his visit while

explaining the benefits of ‘free-choice learning’ based on the individual’s interests (Falk, 2005, p.273). His later realisation of the purpose of the visit was also a statement that frequently recurred in other students’ interviews. When entering an unfamiliar space, most of the students did not engage with the given resources immediately, especially if there was no tour guide or set objectives.

Another problem the students encountered was the layout of the digital room. As discussed in Chapter 4, this room is thematically organized, starting with Churchill’s time in office during World War II. Although the students were briefed on the digital room, the layout seemed to obstruct many of them. This may be a reflection of the museum director’s statement that one of the goals of the museum is to allow students to self-discover material, more like a researcher; thus, this ‘post-modern’ organisational style with no conventional chronological route is intentional. The problem with this approach is that when entering into a new and potentially intimidating environment, students found it difficult to instantly relate the contents to their existing knowledge or personal objectives. As Hannah from Group E explained:

> I found that it was quite hectic in the room. It has too much interactive stuff in the room because you don’t know what to look at each time. You only have a certain amount of time to go ’round the museum, so it would be more helpful if they could just tell you what kind of things you should look at or what device you should particularly look at. It should be a bit more organised.

Three other students agreed with her. Hannah explained that they did not have enough time to fully explore, grasp, and interpret the meaning behind each exhibit or device because the contents of the museum were unfamiliar and in an out-of-school context. Mark, another student in Hannah's group, expressed similar sentiments:

> I think it's better if they just tell us, so we know what we are doing at the time and we get to spend more time on each thing. So we can just see everything, not just going around hectically.

He suggested that due to the brief time they were allowed to spend in the museum—less than an hour in total—the students would have been more efficient in understanding each exhibit if there had been more organisation. Without a prearranged direction in which to focus, it was harder for them to independently self-organise or even learn any new information in such a short space of time. Ellie from Group F stressed this:

> I learnt quite a bit about the museum. I really like the museum, but it probably has stuff that I missed out because we were in a bit of a rush.

For her, the time pressure of the activity meant that she could not fully embrace or familiarise herself with the architectural arrangement and contents

of the museum. This negatively affected the students' attitudes toward the exhibits, as, in most cases, the students browsed or interacted with the device impatiently. This was shown by the short time spent on each exhibit and underscored by statements from all groups expressing a need to keep moving. Therefore, the importance of focusing on an open topic is essential for the student to engage with learning new material. As Laura from Group F explained:

> It was more interesting to learn through the activity than just walking around the museums and reading things…I still remember that we found out different things about his life and decisions he made, like, to join the army or, like, to change his job. I don't know why I am more, like, into it, but maybe because we were researching about his life. I was very into researching about this.

This reflects the interaction between the students of Group F, who concentrated their attention on a topic yet, during this 'researching process', were able to select and combine different resources through various devices and exhibits. They found this task-driven activity helpful in assisting them to understand the exhibited material. Although there was no specific factual information, such as specific historical dates or names, that Laura could clearly remember or relate to her history curriculum, this research process was a learning method that she and her peer group found useful. Hence,

having this task-based activity served to sustain their interest in the contents of the museum. As Ellie from Group F said:

> [For the activity,] you have to learn something very specific about [Churchill]; it's not just like reading about anything that stood out more. It's not just like a worksheet to fill out, but something that we have to find by ourselves. And that kept us going.

Ellie's statement indicated the importance of having a focus so that she could learn something more explicitly. To some extent, this task-driven interaction sustained the students' motivation to creatively and collaboratively explore a topic in greater depth.

The previous section depicts the ways in which students initially think and behave when entering an unfamiliar learning environment. This section discusses how they further manage in these conditions—sometimes without a clear indication of what should be read or looked at, or without any prior knowledge about Churchill.

For most students, the form of learning tended to be less direct and more self-exploratory. As Kate from Group E summarised:

> I mean, there is a lot of stuff as you go along, but when you search about one thing that you might learn about, [you find]

another thing as you progress.

She explained that in order for her to learn, this meaning-making process occurred when she investigated one topic from the museum's tremendous store of information. One observation might lead to another new discovery by selecting required goals and accidentally encountering new interests. This sentiment echoed many other cases in this study, particularly Group D (see Section 6.2), when Chelsea and Dominic looked for information related to the characteristic of reliability in Churchill's style of leadership. They stumbled upon the ceramic miniature of Churchill's head with a dog's body, then connect this observation with a related topic when Chelsea asked her teacher about it. Similarly, in Group E (see Section 6.3), while Hannah tried to navigate the Lifeline in search of a particular date, she noticed something new but relevant to her search, and began to exclaim over it. This unexpected and accidental encounter indicated the students' freedom of choice, but also suggested the possibility of confusion.

Although some researchers have mentioned the importance of learning objectives or activities in providing a focus or guide for students in stimulating their interest and motivating them to explore, many still believe that the factor determining students' learning is this type of self-exploration through personal interest (Griffin, 2004; Falk, 2005). This study, however, inclines more toward Bamberger and Tal's (2006) finding that retaining certain controls in the context of such freedom may be more suitable for providing this kind of unpredicted learning outcome, as well as some basic knowledge.

6.8 Novelty of multimodal technologies

To inspire students to observe and explore, the initial visual attraction depends on the presentation and interpretation of the exhibit. The use of multimodal technologies in a museum may not always be the sole factor that motivates visitors to learn or develop new interests. Still, the novelty and accessibility of the 'fun' factor in these devices appeared to be instrumental in encouraging the students' interests. This was discernible in all the interviews in this study. As Dominic from Group D confessed:

> At first, when I first entered into the digital room, I said to myself that this is fun. Well, it looks fun. It just has a lot of colour and stuff, but then it just had a lot of stuff that we have to read into it. It wasn't too bad, but it just had too much text for me to read.

He acknowledged that the colourful visual representation and the game-like appearance of the multimodal devices and exhibits made him willing to participate; however, the overload of textual material discouraged him from continuing. Therefore, one cannot deny the fact that the novelty and entertainment aspects of the digital resources attract students' attention initially, which fits with many institutions' plan to invest in the latest state-of-the-art technology to attract more young patrons (Meisner *et al.*, 2007). The delivery of the content using text is sometimes inevitable, but it was discouraging for many of the students.

What this museum offered in the way of 'multimodal technologies' is, in a sense, similar to Gee's (2007) concept of interacting with games, which has been seen as a platform that embraces strategies using a variety of modes or factors, such as images, words, sounds, and bodily sensations. Through playing games, one can share new, group, and prior knowledge, skills, interests, and exhibited resources formed by the visiting experience. Therefore, when visitors encounter alternative methods, such as the use of multimodal technologies involving, for example, touching or watching videos, they find these devices more appealing and stimulating, as Peter from Group F attested:

> I thought that it was not that good at first. I thought it was just showing Churchill and everything in text and some documents. But then when we looked at the technologies, it was more modernised. It has all the sources and the touchscreen, sound and pictures and stuff that made the thing more interesting.

His statement is borne out by the scenario (see Section 6.3). When Group F first entered the museum, Peter was less active and vocal. He then gradually became more talkative, especially when he walked toward the Lifeline, as he had not expected the museum to provide such multimodal material. He even exhorted one of his companions to look at the Lifeline. This suggests that Peter's interest and confidence grew as he became more comfortable with the

spatial arrangement of the digital room, the content of the museum, and the multimodal digital devices.

The use of words such as ‘interesting’, ‘fun’, and ‘better’ occured in a few students’ interviews, which suggested that they enjoyed learning in this setting. It also suggested that they were consciously aware of their own learning methods. Most of the interviews, instead of stating disconnected information or facts, described in some detail the speaker’s self-discovered methods of improving her own understanding and learning. In Laura’s case, for instance:

> [The telescope device] has a lot of information, but it tells you to look at this and look at this. Then you would know about what to look at, like, and you learn about it. There is a lot of text on the wall, but because there are sounds that tell you what’s going on too, so it’s a lot easier to find things and keeps me going for what I was searching for.

Laura illustrated the content of the digital room in depth, plus the kinds of modes she had encountered that supported her needs, such as the telescope device. She emphasised the importance of learning by being instructed by the device about what to look at and read initially. She then explained how having additional narrative sound effects with the text sustained her interest, assisted her reading, and motivated her to search for more relevant information from different devices and exhibits during the museum activity. Her long description

of the video she watched through her telescope is testament to this. In that case, her attention was enhanced by the sound effects and the narration of the device. She then began to explore further through reading the textual panel next to the device out loud, and made further comments in her attempts to interpret the event in relation to the museum activity. This echoes Paris's (1997, p.24) statement that '[w]hen visitors in museums work to understand, they focus on the processes of learning, the ambiguities of problems, and multiple perspectives on objects.' He describes how visitors' behaviour in museums tends to focus on their own learning methods and developments, due to this exploratory nature of absorbing new understanding and embellishing previous knowledge.

6.9 Exploring individual interests

Of course, one must be aware that Laura's interactions may not be applicable to all of the students, as different students encountered different modal combinations and had different preferences. As the interview data showed, the concept of 'learning' was acknowledged by the majority of the participants. The differences seen arose from their learning methods and individual preferences. For instance, Peter from Group F commented:

> I sometimes think that simple technology is better because it's easier to understand and have a look at, like, just some text and pictures.

Peter suggested that state-of-the-art technologies may not always be the best solution for learning purposes. A straightforward text and image would be more suitable for him. In addition, Dominic from Group D preferred more physical authentic exhibits:

> I think the touchscreen and choosing folder, and even typing numbers into the device are really good, but I would rather prefer to see the real thing rather than just a picture. I think it really depends; you don't really have to have technology in everything. The bits without the technology had more information and were more interesting. But it was easier to access with the technology.

Dominic discussed his overall experience with both the technologies and the authentic exhibits. He indicated the balance between them and the advantages of having authentic exhibits in relation to technologies. Although he liked the technologies, he found authentic exhibits more valuable for his learning experience.

Another widely discussed and adopted learning method in museum-based learning literature is the trial-and-error approach through either discovery or overcoming challenges such as problem solving activities. This is in line with most of the students' feedback: for instance, Kate from Group E stated:

> I actually think that Churchill [as a topic] is not as boring as I thought. I actually quite enjoyed finding more stuff about his life. He actually had an interesting life and everything to find out. It's better that we get to find out more about him because we don't get to learn about that sort of thing in school. And it's just different from just reading about text, but different stuff. It's more interesting.

Kate's explanation typified a commonly-held attitude expressed by most of the students: Reading textual material was what they expected when entering a museum, which they considered to be boring. During this museum visit, however, Kate found it more engaging and challenging to search for information about a public figure's life, which was different to their school learning methods and outside the limits of their curriculum. Moreover, when asked to expand on what she meant by 'different stuff', she explained:

> For me, I like certain bits with sound, and there was video while there was text on the side, if I don't get it. There was also a place with his first gun. I think it was really interesting to have bits of everything together. That really keeps me going and understand better. I also think it's better to have the activity in a group so you can really discuss with your friends, otherwise it would be quite boring.

This explanation provides a comprehensive account of the importance of combining different modes through various representations and technologies. She emphasised the importance of having sound, video, and authentic exhibits, as well as textual material, to sustain her interest in the topic. The combination made her learning experience more valuable to her understanding of history.

6.10 Constructing and sharing understanding

In the quote above, Kate also stressed the importance of the peer group in negotiating meaning and sharing understandings collaboratively. Many researchers, such as Paris (1997), have observed that the characteristics of working as a group, such as sharing the same focus and commitment, encourage students to reinforce their understanding and contribute to a task more fully. This brings the focus to the exploration of the social dimensions of these forms of interaction, which Kate highlighted earlier:

> [I]t's better to have the activity in a group so you can really discuss with your friends, otherwise it would be quite boring by just reading the text yourself.

This leads to the observation that learning value is derived and determined by the students and their interactions with the exhibits and devices. The use of the word 'boring' references the common problem that many museums try to improve, which is to sustain visitors' interest. Although Kate specified that just

reading the text would reduce her interest in the topic, she emphasised that the social aspect of discussing similar topics can make the meaning-making process more stimulating.

The role of the technology here, in a way, is to provide a shared platform for social interaction, which allows students to generate their own knowledge. For instance, all three groups of students became more vocal about what they observed in order to communicate with their peer group while interacting with the digital device or reading from the textual panels. In Group D, for example, when Chelsea tried to open the digital files, she read out loud what she saw in the Lifeline while interpreting the content. In Group E, Hannah expressed her thoughts and opinions out loud as she physically interacted with the device. Laura in Group F similarly read out loud from the digital screen while pointing out the interface to Ellie. Here, again, the content of the device was reconstructed through Laura's one-way interpretation and analysis by reading out loud while interacting with the device. All of these examples are reflected in Chelsea's explanation that:

> The group activity made the experience slightly better because if you have enough people's opinions, then it's a lot easier to make something out of it, especially as we didn't know much about Churchill. That kind of helps! And if I just walked around by myself, then I wouldn't manage to do anything.

She stressed that by embracing a larger group of people's opinions when encountering unfamiliar subject matter in a museum, her understanding and overall experience was augmented. The shared group experience through activity, such as watching another person interact with the device and reading from textual panels together, provided a more tangible collective platform from which to perceive, evaluate, and exchange ideas. Success here depends on the ethos and culture of each group, however, as illustrated by Emma in Group D, who stated:

> The activity was kind of boring. It was like we have been told to go and find something, but if we don't like what we are doing, then it's just boring. We have been told to make notes of other notes. I mean, the quotes [textual material from the textual panels] were good and I quite like it, but because that's what we do in school, like we find a quote and analyse it. So it's really repetitive.

She indicated the repetitive nature of copying text onto a piece of paper, but also her lack of interest in the museum contents and, by implication, her group's lack of interest. Despite her negative attitude, which was rarely encountered in any of these interviews, she did not deny the prominence of group interaction; for her, the repetitiveness of the drill and practice skills, such as analysing quotes in history lessons, mirrored the mainstream learning culture.

Social and entertainment cultures are embedded profoundly in museum-based learning. This 'fun' factor is therefore imperative when designing an educationally-orientated technological device. The aim of this is mostly to provide learning opportunities for students that are sufficiently different from a typical school setting, but also visually stimulating enough for them to engage and interact with. As David from Group F affirmed:

> The interactive services, [Lifeline,] that sort of thing, made it [the learning experience in the museum] more interesting. You can just pick up a day and look at it and put it back and see what's going on. It is something really different you see. And when we went into the museum, I didn't expect to have any fun.

David elucidated the process of using the digital interface, which provided an alternative content delivery system. Moreover, as previously mentioned, the students usually expected the traditional text accompaniment to authentic physical object representation. Therefore, harnessing different modes in the digital device was considered a novel and enjoyable approach by the students. This is in opposition to both mainstream learning and the home environment; the large digital devices and exhibits are spatially arranged and situated in a theme park-like setting, hence, the meaning-making processes in the museum can be associated with 'fun' and inspire students to perceive information creatively and innovatively (Kirriemuir and McFarlane, 2004).

6.11 Conclusion to Part B

In many museum-based studies, researchers avoid discussing students' frustration in engaging with the museum content, whereas the data discussed above illustrate that student may simply express a lack of interest with no apparent underlying rationale. This study deliberately seeks to explore the 'why' and 'how' behind such statements, but also to further investigate whether the student visitors have nevertheless gained a learning experience through such meaning-making processes. The findings for this chapter are slightly different to those from the Natural History Museum, as two museums' subject matters have different representational qualities and contexts. Additionally, the more textually-based representations and material that is less applicable to the school curriculum or young students' personal experiences made the Churchill Museum more unfamiliar and challenging to engage with immediately.

Furthermore, due to the lack of time allotted for the activity and their limited background knowledge of Churchill, the students found the content and the arrangement of the museum less accessible and approachable without an activity or learning objective. Nevertheless, through trial-and-error exploration of unfamiliar material, the students became more aware of their own learning methods and preferences in adopting new knowledge. The initial attraction and novelty value of the multimodal technologies motivated them to read and engage with the content, but also supplied a more transparent visual platform for sharing interests and focusing group discussion. This made the

learning environment more accessible and stimulating, mitigating the imposingly authoritative impression and prior expectations of the museum. From the students' perspectives, the importance of combining all the different representations, such as authentic objects, textual panels, and technologies, with an activity was pivotal to adding value to their meaning-making processes and understanding of learning. It may be added here that the schools should have prepared the students prior to their visit on the basic context of the topic—through picking fragmented facts and constructing disjointed information through their own casual conversation, students' misinterpretation and misconception of history or facts was a likely result.

Chapter 7: Discussion

7.1 Introduction

This chapter summarises and answers the overarching question:

What is the relationship between engagement and learning in school students' interactions with technology-driven multimodal exhibits in museums?

It connects the findings and discussions from Chapters 5 and 6 with the reviewed literature and chosen methodology. Through the use of multimodal analysis and interviews, this discussion unravels the issues and perceptions raised in the current literature about how schoolchildren engage and learn in museums with multimodal technologies in connexion with other factors, such as the presence of museum educators, exhibits, textual panels, and museum activities

This chapter begins by discussing the role of multimodal technologies in supporting students' museum visit interactions with their peer groups, authentic objects, and the content of the displays. This is followed by considering the ways in which these interactions relate to individuals' meaning-making processes and to the resulting challenges encountered, and contribute toward their concepts of learning. From this, the discussion considers the research questions and attempts to determine whether students learned or merely engaged during their museum visit, and whether they had

retained any knowledge six to eight months later.

7.2 Initial engagement with multimodal technologies

Drawing on the findings and discussions from Chapters 5 and 6, an underlying conclusion of this study is that the concepts of *engaging* with museum exhibits, especially multimodal exhibits with technological aspects, and *learning* during museum visits are quite distinct. Engagement is required for learning to occur, and learning often depends upon interactions, from the physical to the cognitive, the technical to the social. Still, not every engagement—even with attractive multimodal technologies—leads to learning. For example, the students in this study demonstrated various forms of engagement; some shared what they had learnt and spoke of being entertained by the exhibits and by interacting with their peer group, but others, especially those who had not engaged well with the exhibits, found it difficult to recall details about their museum experience. Between these two extremes were students who had engaged with the multimodal devices, yet may not learn. It is thus crucial that museums hoping to understand the relationship between engagement and learning with a particular multimodal technology first identify the role of the technology being studied, then determine whether it is a tool to support learning or merely an entertaining experience.

Sensory Stimuli

Museums design multimodal technologies to facilitate multiple modes of communication for a wide range of audiences. On the practical side, the digitalised content allows museum curators, designers, and educators to

update their information as well as present entertaining and aesthetically pleasing displays. As the users in this study were secondary school students coming to the museum on field trips, having these technologies on top of the traditional curatorial style of authentic and untouchable exhibits with textual labels made for an authentic multimodal experience. The digital components were an unexpected feature and style of presentation that the majority of the students had not anticipated prior to their visit. Hence, the multimodal characteristics attracted their attention and roused their curiosity, making the content seem more stimulating.

The multimodal analysis from both museums suggests that when the students entered into these unfamiliar spaces, their sensory-stimulated actions revealed a state of ready anticipation, perhaps because of their uncertainty over the challenges they might face. The practical design considerations of these unfamiliar spaces, with their dim lighting and cinematic atmosphere, increased the likelihood of the students heading toward the sound, moving images, and bright screens. Here, multimodal technologies acted as sensory stimuli. Psychologist Nicholas Humphrey (2006, p.70) emphasises that the physical moment-to-moment of feeling (*i.e.*, sensation) and the mental and emotional process of apprehension that generates knowledge (*i.e.*, perception) are inseparable activities in generating experience. Yet he theorises that it is the aspect of sensation that takes precedence in allowing one's inner mind to interact with the 'external world', in this case the museum exhibits, technologies, text, or even the architecture of the building. This initial attraction serves to catch visitors' attention initially,

which is a major facet of the multimodal technologies' contribution. For instance, the physical action of 'touch', such as opening a file in the Lifeline at the Churchill Museum or 'dragging' an object into a bag in the 'planning your expedition' device at the Natural History Museum, played an important role for each of the six groups of students. The mode of 'touch' provided the notion of involvement and physical participation for the students, even with nothing more than a screen to provide a tactile sensation. This empowered them and offset the 'hands-off' authoritarian impression associated with such institutions, creating an atmosphere of greater approachability.

The 'hands-on' feature is not new—showing videos and giving visitors access to devices with handles to pull and buttons to press were techniques used in the1980s, and many researchers have found that visitors are more engaged with topics if they can use such technological features (Koran *et al.*, 1984). More recently, however, museums have added devices that integrate diverse modes into installation, which allows the interface to be more spontaneous and interactive; the 'planning your expedition' device, for instance, provides a virtual instructor, touch sensor, sound effects, and video. The multimodal technologies act as a new platform to introduce visitors to a topic and help inspire their interest. They allow visitors to watch and learn from other visitors' hands-on interactions, then experience these interactions for themselves. Rather than experience a device as solitary users, then, visitors interact with both the device and with each other, which can create a more memorable experience. In the student groups in this study, for example,

the sensory stimuli that the students received were derived from both the device and from observing others.

On another level, as discussed in the literature review (see Section 2.2), there are many assumptions about the influence of advanced technology on the culture and social behaviour of the young generation, and the attention of 'context and content' should not be overlooked; these two factors are essential in determining the impact of a device. As discussed in Part B in both Chapters 5 and 6, the students acknowledged and appreciated the usefulness of highly advanced technological design, yet they find it more helpful and important to have straightforward guidance, through technological means or otherwise, depending on the distributed information and objective. Thus, when it comes to helping students engage with the content of a museum, direct and simple communication is more important than the latest technology.

Motivation

Having understood one of the main functions that the multimodal technologies provide, the next logical line of inquiry involves considering the consequences of these sensory stimuli. From the multimodal data and the follow-up interviews with the participants, three themes emerge about what the uses of technology achieved. Firstly, technological devices provide a more positive attitude toward the museum experience. Secondly, utilising these technologies inspires motivation in visitors and encourages further engagement with the topic. Thirdly, these devices encourage individual self-reflecting learning methods.

Allowing the students to participate physically with the museum exhibits made them feel more at ease with the environment. Most of the students expressed this feeling using words such as ‘enjoyment’, ‘interesting’, ‘fun’, and ‘satisfaction’ in relation to both the exhibits and the museums. As psychologist Ormrod (2011, p.400) suggests, ‘[L]earners are more likely to engage in meaningful learning and thinking creatively about a topic if they are in an emotionally positive frame of mind.’ On one hand, this statement suggests that students could be more open-minded toward the content of the displays due to the positive attitude fostered by the devices. On the other, it leads to the possibility of museums incorrectly gauging how much their visitors learn by how much fun they are having. This study suggests that not every student is a ‘learner’ in a technology-rich context. Having fun or engaging with exhibits does not always result in learning.

What this study illustrates, as borne out by the multimodal data, is that technology leads to an increase in physical and vocal participation, both as groups and as individuals. For instance, at the Churchill Museum, the students vocalised their thoughts to others once they physically interacted with the device. At the Natural History Museum, as the students became involved with the hands-on device, they became expressive about their personal and prior experiences, and situated their thoughts in relation to the exhibits during interactions with their peer group. Although there is no direct link between learning and fun, this study suggests that as technological elements are likely to lead to positive attitudes among school-aged visitors,

when these elements are present, these visitors are more likely to pursue further meaning-making processes.

The positive attitude apparent in most of the groups in this study indicates that the devices energised the students to be interested and sustained them as they worked towards a particular goal. This may relate to the previously mentioned concept of 'need of cognition' (Cohen *et al.*, 1955; Cacioppo and Petty, 1982)—the individual's inclination to engage in and enjoy thinking and learning, depending on his preference and personal interest (see Section 2.5). As well as providing the initial spur, this positive attitude also influenced the students to pay more attention to and spend more time with the other exhibits. During such active investigation, some students faced interruptions and frustrations, such as the technical problem that Chelsea and Dominic encountered in the Churchill Museum (see Section 6.2), or excitement toward different exhibits, such as Nathan and Alex's active interactions with authentic insect specimens after interacting with the digital devices in the Natural History Museum (see Section 5.4). The 'situational interest'—an immediate experience that is provoked by the environment, which can be new, distinctive, and even unexpected—may be provoked through these processes. (Ormrod, 2011, p.362). Alternatively, the opposite outcome is possible—frustration with a device can decrease one's motivation to visit the exhibits, leading to the feeling of a 'boring' visit.

Regardless of positive or negative opinions of the exhibits or the multimodal technologies, in all of the interviews it appeared that the students were conscious of how the content and the modes provided from the devices

could be improved or could assist with their learning methods. They especially appreciated the design and the content constructions in relation to the rest of the museum exhibits, but also reflected analytically and critically on different methods of learning. This is not to say that students go to museums knowing their learning intention, but still, the majority of the participating students spoke of 'learning' as part of their focus within their overall experience of the museum. This may have been due to their participation in this study, but arguably, when the students expressed their perspectives on their experience, even when the interview questions were opened to any opinion, their discussions were oriented around learning methods and learning experiences tailored to their needs, as discussed in Part B in both Chapters 5 and 6.

7.3 Development of meaning-making processes

The forms of the students' interactions were complicated, varied, and random in order, depending on the group and the encountered exhibits. These interactions may not be attributed directly to one's cognitive development, but considered as a process of interpreting certain meanings. As Hooper-Greenhill (2000, p.4) points out, an object contains multiple meanings through visual and verbal communication. To further complicate individual interpretation in this case, the two museums provided extensive tacit responses and sensory experiences, which made it even harder for the students to articulate their experiences and relation to their prior knowledge, preferences, and routines (*Ibid.*). Therefore, the combination of these intended meanings from the museums may not be fully delivered as a complete and

direct outcome of learning. This is not necessarily a drawback—rather, one should be aware that individual processes of meaning-making are subjective and personal. The outcomes of the students' interpretations thus varied considerably, depending on the students' sociocultural background (*Ibid*., p.119), but also on how the situated comprehensions of their interactions and the later interpretations were forged and refined. To construct an in-depth model of an individual's meaning-making processes allowed me to understand the ways in which these interactions were interconnected and related to learning.

Below, the forms of meaning-making interactions are categorised into three sections: observation, conversation, and participation. This study found no particular hierarchy to these forms—instead, they share reciprocal relationships.

Observation

The concept of learning through exploration is discussed widely in the literature on museum-based studies (Hein, 1998; Macdonald, 2011). One of the main functions of the museum is to inspire and enable people to explore the collections (Museums Association, 1998); thus, for many museums, in particular the two in this study, museum directors and device designers aim to provide a more accessible and wide-ranging research environment for their visitors. As every visitor has a different visiting agenda and preferences, however, museums face the dilemma of deciding whether an object can 'speak for itself'. Hence, the curatorial rationale behind the design of the exhibits and architectural arrangements is to amplify an object's 'voice'

through different learning methods in an attempt to create as many learning opportunities as possible.

In this study, the visual mode was an initial factor; its importance stemmed from its ability to trigger other modes. Many of the students' interactions revolved around looking at how others explored the space. They then imitated the observed actions in order to accommodate their own performance. For instance, in Group A at the Natural History Museum (see Section 5.2), Chris, Steve, and Amy observed each other's physical interaction with the multimodal technologies and took turns to try to complete the task. Through such interaction, they were able to relate their previous observations from the textual panel and information about authentic exhibits to the device in order to achieve the goal. An example of this is the moment when the three students encountered the question of how to preserve delicate specimens and were presented with a choice of two images: a pair of blue gloves with a Ziploc bag, or entomology forceps with a pin. Chris immediately reminded the other two of what he observed at the previous exhibit on mosquitoes. The technology here provides a transparent, shared, visual and aural platform to allow the students to vocalise and sometimes visualise their own actions, decisions, observations, and thoughts. They became more vocal about their physical movements and contemplation as they become more comfortable with the environment. Sometimes, there was also an increase in non-verbal interactions as they acknowledged each other's intentions.

Analogously, in the Churchill Museum, Hannah and Kate's (see Section 6.3) observations of each other lead toward a discussion. Hannah's perpetual

exclamations about the Lifeline drew Kate's attention to Hannah's physical act of 'clicking', the content, and Hannah's new discovery, as well as the thought process behind all the modes of action. This form of interaction established a mutual foundation for them to converse and build further understanding, which will be discussed in the following section.

Conversation and collaboration

As mentioned in the literature review, many museum-based studies find that small clusters of some form of conversation are vital to construct meaning in museums (Leinhardt and Crowley, 2002; Benjamin, Haden, and Wilkerso, 2010). This social constructivist approach of building knowledge and observation through social interaction is commonly acknowledged in this field (Heath, vom Lehn, and Osborne, 2005; Hohenstein and Uyen Tra, 2007). Many researchers stress the importance of dialogue, which is considered the primary medium for knowledge construction. However, to what extent and in what ways are these conversations implemented as constructive, meaningful resources rather than a random assortment of assumptions? This study may not be able to answer this question directly, as one cannot generalise the overall outcome among the six groups. Still, the recurring patterns from the multimodal data illustrate that, alongside the students' personal observations of the exhibits and their interactions with the multimodal technologies, conversation was an important influence that allowed them to construct their prior experiences, personal interests, and situated opinions. The construction of these situated and conversational interactions indicated constant development of meaning-making toward the same subject area or to similar

topics. Indeed, as both museums are activity-orientated, the conversation, questions, and utterances seen in this study were concentrated around a particular topic. Although there was a potential that students would ignore the given topic or activity due to the museums' non-assessed and voluntary nature, the students still followed their instructions. In particular, in the interviews, a large number of students suggested that having a well-defined learning objective or instruction made their visit more enjoyable and productive.

The student interviews from both museums also suggested the importance of visiting the museum as a group, which provided students with opportunities to exchange their thoughts and ideas with their peer group. In the case of Emily and Charlotte from Group B, for instance (see Section 5.3), museum educator Jill provided more spontaneous and face-to-face 'explanatory-based feedback', which included problems and questions, positive encouragement to complete a task, and feedback (Kohler, 2002: Coutinho *et al.*, 2005). This motivated and provided a structure for the two students to further engage with the investigation; through such interaction, they became more vocal about their thoughts and questions, whilst the feedback from Jill provided them with more authoritative scientific knowledge.

In the Churchill Museum, on the other hand, the students in Group F (see Section 6.4), who did not have teacher or museum educator assistance, acquired information and understanding through group conversations and situated assumptions from text, authentic exhibits, and content from the multimodal technologies. Still, although their conversation showed many

misguided and unfounded assumptions, it still showed how they analysed, criticised, and adopted the alleged information. Their conversation, therefore, could be seen as a reagent that allowed them to construct a meaning-making process and, in some cases, provoke further investigation.

Participation and collaboration

Following the forms of conversation, the other important component was participation, which included further discussing the explored topic with a peer group, taking notes, taking photographs of an object, taking part in another activity, or being more active in exploring more exhibits. These active forms of interaction generally suggested possible enjoyment, curiosity, or even aesthetic appreciation, although arguably there were some potentially negative factors involved, such as peer pressure or compulsion from schoolteachers. In this study, most of the interactions and interviews did not suggest any unwillingness on the part of the students or any feeling of obligation emanating from the schools or museums.

The interactions at the Natural History Museum showed most of the students being increasingly animated in their bodily movements and conversation in their groups as time passed. The multimodal technologies drew their attention and encouraged them to get involved and find other relevant resources or exhibits. For instance, in Group C (see Section 5.4), Alex and Nathan were initially impressed by the design and content of the technology, so they started touching all of the possible digital devices and playing with every game. They also became more vocal in expressing their personal interests, past experiences, or personal opinions in relation to what

they observed. In addition, they became more confident in describing their observations to others in a 'talk out loud' behavioural style, which attracted other students' attention; these students, in turn, discussed what they had observed. For instance, when Nathan said to Alex, 'It's really good in here actually, it's generally good!' their classmates, Roger and Jason, followed them to the next exhibit.

It was much the same with the Churchill Museum visitors, in particular Group E (see Section 6.3). Hannah and Kate instantly began by questioning the authenticity of the object; question-and-answer dialogue between the pair was followed by participation in finding the relevant resources from the multimodal technologies to complete their museum activity. This physical objective of searching, browsing, and comparing was an active form of participation. This allowed them to explore further in connexion with their personal interests, preferences, or even the school curriculum. Like Nathan and Alex at the Natural History Museum, Hannah and Kate became more vocal about their thoughts in relation to what they considered important to write down. For instance, when Kate was trying to explain to another student what her group was doing, her file closed. She yelled at the device, 'Wait! I was reading that!' She then turned to another student and said, 'It was 1937, it was 1937, it was September.' Hannah turned to Kate and said, 'Oh, I just wrote that.' They then shared a mutual understanding and were ready to move on and search for more information from another device. Their participation was task-orientated, yet there was a constant active motivation to seek more information. This motivational factor in enhancing visitors' learning

experience has been much discussed and explored (Falk and Dierking, 1992; Packer and Ballantyne, 2002). These studies highlight how motivation increases confidence and, in consequence, the tendency to enjoy thinking and improving one's own knowledge development (Cacioppo and Petty, 1982; Cohen, Stotland, and Wolfe, 1995), which leads to this effective sequential participation in different meaning-making processes in enhancing one's understanding.

7.4 The students' challenges, collaborations and problems

During these interactions of active observation, conversation, and participation, challenges, questions, and problems naturally occurred as the students proceeded. The result could go in one of two ways: Either the students would be more engaged with the exhibit or become perplexed by the content and lose interest in participating further. This may explain the rationale behind many students' short attention spans when encountering an exhibit and be the cause of lost momentum in their exploration. There were innumerable potential obstacles, but for the purposes of this study, the primary obstacles are discussed below in relation to their magnitude and effect on students' meaning-making processes.

Lack of time to spend on each exhibit or device

The lack of time was mentioned in interviews with students at both museums. They expressed frustration at not having enough time and space to fully engage with the exhibits or the multimodal technologies. In conjunction with the students' lack of preparation on the museum subject matter, they

found it hard to construct an efficient meaning-making process with the many objects presented to them.

Furthermore, in most of the schools, the accompanying teachers were not specialists on the topic. Therefore, both the students and the schoolteachers could be without a specific learning goal, focus, or agenda when visiting the museum. In addition, the majority of the schools had no follow-up session or review of the visit, although one cannot place all of the responsibility on the schoolteachers or museum educators due to the problems of the lack of school staff to support all the students and the additional time needed to conduct a separate session on their visit on top of the school curriculum. For the museums, funding and policy constraints are a hindrance in providing more museum staff to support this type of school activity.

At both museums, the students had a certain time in which to explore in groups, which, coupled with a high volume of visitors, led to their rushing through exhibits. The students at both museums stated that if time and space permitted, they would have been able to construct their meaning-making processes more holistically and form a more coherent understanding of the exhibits. The lack of a follow-up session was also connected to this lack of time; not every student was interested in the content of the museum, and the teachers simply lacked the time to try to make all of their students gain something from the visit. This may be one of the factors that affected students' longer-term recall of what they had learnt at the museum, as there was a lack

of opportunity for the students to relearn, refresh, and relate the content to their lives.

Technical problems with the digital elements were also likely to occur on occasion. In most cases, this problem discouraged students from paying attention to or persevering with the device, examining related exhibits, or even reading the text (see Section 5.4). Robust, practical, and straightforward design of exhibit displays and technological devices should therefore be a priority.

Peer groups with different interests and attitudes

Irrespective of the school's input, students' attitudes toward their visit came down to their motivation, personal interests, and situated observation within their peer groups. In general, emotional aspects, such as the extent to which there is enthusiasm and a positive attitude in a group, occasionally regulate students' attitudes toward learning (Paris, Yambor, and Packard, 1998; Packer, 2006; Eshach, 2007). The students in the six groups had a positive learning experience while visiting the museums. They also expressed their personal interests and preferences regarding to the content of the museums, as well as their discoveries and interactions with the multimodal technologies. This result, however, cannot be generalised to all of the participating students, as the accompanying schoolteachers pointed out that due to time constraints, varying levels of interest, and limited opportunities to fully utilise the devices, some students did not appreciate the exhibits and proceeded swiftly toward the end of the exhibition.

Even if some students failed to learn, the positive experience they had at the museum—even if it was merely entertaining—could eventually lead to learning. Students who enjoyed the museum might be inspired to make a repeat visit, possibly with their parents. This sets the stage for further potential learning experiences.

The motivation to participate further or to be dissuaded from doing so can be affected by personal interest, but also by the ways in which other students learn and express themselves. For instance, Nathan in Group C at the Natural History Museum demonstrated a strong interest in science and was able to convey his excitement with Alex and his other classmates. This inspired more students to join in Nathan's interpretations of the specimens and experience the digital devices. In the case of the Churchill Museum, Ellie, David, and Peter from Group F (see Section 6.4) depended on Laura's personal articulation and decision-making. While reading, selecting, and combining random textual panels and fragments of written resources from the multimodal technologies, they relied on Laura's assumptions and interpretations to shape their conclusions concerning whether Churchill was a reliable leader. Without specific guidance from the museum educator or direct support from their teacher, the results of this activity could be problematic, as they were often based on the confused students' guesswork.

The issues mentioned above have been raised and discussed by many researchers. The debate about the potential of full collaboration between museums and schools remains, and some have even explored the potential of pre- and post-platforms, such as museum website activities (Griffin, 2004;

Vavoula *et al.*, 2009). The debate is often refocused on the essential functions and obligations of the museum—not solely or directly to provide an extension to the school curriculum, but rather to display an inspirational, accessible collection for the public to engage with and enjoy at their leisure. This issue of full collaboration between schools and museums also indicates the importance of understanding how the aforementioned interactions may influence each other. If meaning-making processes are better understood, schools and museums may be able to better support students' learning and motivate them to explore. To put it succinctly, for students, learning in museums is not the result of a single factor—it is the result of the interaction of multiple platforms. Consequently, multimodal technologies cannot work in a vacuum and create meaning-making processes, and schools and museums need to be aware of this fact. Although the challenges of school-museum collaboration were less recognised as an important factor in the past, having been overshadowed by complicated policy and funding issues, as well as by the dilemma of deciding in what directions museums should go, this thesis suggests that these challenges, problems, and questions should be considered pivotal in fostering the connexions and integration between students' meaning-making processes and learning.

7.5 Relating the forms of interaction to learning

Students' perceptions of learning and knowledge

In answering and discussing the second operational question, on the ways in which students relate their forms of interaction to learning, one has to

undertake the challenge of understanding 'learning', or even the constitution of 'knowledge', in these museums' context. As discussed in the literature review, the learning experience focuses on the situated moment in making meaning and forming judgements, rather than a retention or repetition of an expected outcome (Weil and McGill, 1989). One may therefore characterise learning in museums as active, continuous, situational, and multimodal.

To this end, knowledge in museum is not merely an acquisition of factual information, whether from sound, an image or video about an exhibit, or information related to the school curriculum. Curtis and Pettigrew (2009, p.160) return to Lankshear, Peters and Knobel.'s (2000) discussion that knowledge is a constantly evolving and organic contestation, 'a source of disagreement, argument and speculation'. Indeed, there is no definite certainty of the truth; therefore, knowledge can, in a way, be conceptualised as progressive and unrestrictive (Curtis and Pettigrew, 2009, p.43). This, in juxtaposition to the context of the two museums and the forms of the students' interactions (*i.e.*, meaning-making processes), comprises a process of reaching for and constructing some forms of knowledge—or, to use another word, learning.

In this study, these forms of meaning-making processes were illustrated and scrutinised at a micro-level of analysis (*i.e.*, multimodal analysis), which indicated that the students' learning experiences were collective, contextual, and, indeed, multimodal. For instance, there was a constant social construction amongst the students and teachers through various modes of action and conversation that were mediated by and

dependent on the context, such as the exhibits, devices, or text. Moreover, in most of the students' interviews, they were able to retrospectively discuss their personal preference of learning methods and critically analyse their perspective and conceptualisation of learning in museums (see Sections 5.10 and 6.10). In some cases, students would even suggest improvements and acknowledge appreciation of the design, activity, and multimodal technologies (see Sections 5.8 and 6.8).

From the students' interactions, one can observe how the students' discussion, challenges, and discoveries were connected to their personal interests. The students were also able to relate their museum learning experience to their school curriculum. In some cases, however, their concept of learning took them beyond the curriculum, such as when Chris from Group A explained that his after-visit experience made him realise the connexion of his laboratory experiments at school to the scientists' undertakings in the museum's research laboratory (see Section 5.2).

As discussed, engagement and learning are interrelated with each other in this context. Learning is more likely to occur through an active experience of constructing and connecting various forms of engagements with the encountered exhibits, digital devices, text, and relevant conversations with peer group members with prior knowledge. Adding technology-driven multimodal exhibits into museums enables more situated physical and vocal interpretations and meaning-making processes by amplifying the different methods of visitor communication. Through such processes and interactions,

more engagements are developed and more opportunities of learning are created.

Beyond the general question of whether the students retained any factual information from their museum visit, another question concerning 'learning' in this study was whether the students came away with an awareness of their learning methods, or in some sense, an awareness of the supports for knowledge acquisition available in the unfamiliar museum environment. The types of understanding that most of the interviewed students suggested were how to critically gather, analyse, and discuss relevant and interpreted information. To this end, the question arises as to whether such understanding was sustained and developed further after the museum visit.

Longer-term impact

The discussion here is not intended to measure the psychological aspects of students' short-term or long-term memory, but rather to understand the ways in which they sustain, extrapolate, or adapt their personal practices through this visiting experience.

The reason for the interview that took place six to eight months after the students' visit was to explore whether, over an extended period of time, the students were able to build on their experiences. Due to the age of the students, however, some had graduated before the survey and interviews took place. With this mild loss from the original 214 surveys and 79 student interviews, the findings for both museums consisted of 179 surveys and 54

student interviews. The differences in the participants' school culture, prior preparation, and individual interests means that this concept of longer-term impact cannot be generalised.

The survey and interviews from both museums reveal that the students were consistently able to describe in detail the appearance, function, design, and sometimes even their personal appreciation of the architectural space and layout. While describing the museum, they acknowledged (to varying degrees) different learning methods encountered through their interactions with the exhibits, in particular the multimodal technologies. The type of interactions they recalled ranged from details of their own past or conversations and remarks remembered from the visit, to device navigation or technical problems. In addition, some could still recollect random snippets of information they read or the content of the textual panels around the device, depending on the individual's interests. This echoes many long-term studies on museum visitor behaviour (Anderson, Storksdieck, and Spock, 2007). This is not to say, however, that the students could not connect what they had seen at the museums to their school material; some of the students from the Natural History Museum groups elaborated further on their school curriculum, as there was a more direct connection between the two. For instance, Chris from Group A described another multimodal device at the museum and stated:

> I can still remember the information on mosquitoes and the models of both the male and female mosquitoes…This related to our work in AS (Advanced Subsidiary level) about malaria,

> what it is, how it is transferred, and the female anopheles mosquito.

Still, such detailed and learning-related discussion was not a frequent occurrence in many students' interviews. Again, this comment did not relate directly to specific scientific facts learned in the museum, but it shows that the museum remained a memorable experience. As Rennie and Johnston (2004) argue, learning in museums is not a single episode, but an on-going and iterative process in which a particular anecdote can be part of an accumulation.

The majority of the students were better able to articulate the process of how they learn than discuss what they had learnt. The overall results show that, irrespective of the individual's interest in the subject of the museum, it was fairly important for her to begin her memories and recollections through describing either the architectural and spatial arrangement of the location or the functionality of a particular multimodal technology in relation to a particular anecdote. As Peter from Group F mentioned:

> I do still remember when Churchill was younger, like when he was in the Boy Scouts, joining the Cadets sort of thing . . . this was because at that point, my friend David and I were thinking about joining the Cadets. That's why.

Peter's recollection reflects his shared experience and personal connection with his friend. As Falk and Dierking (1997) have found, visitors tend to remember everything that relates to their own visit or personal agenda, but not the details of the museum contents. This study may not have enough evidence or data to confirm such assertions, yet there are some elements that may connect to these aspects.

The overall level of retention of the students' experience was inconsistent, which reflects the previously-discussed problem of the lack of initial learning objective, preparation, and background knowledge of the content and context of the museums. Thus, the outcome was dependent on the individual's interest level and prior knowledge, and the activity's relevancy.

7.6 Conclusion

The previous two chapters and the present chapter have extensively explored the forms of interaction between the school students and the technologies as well as looked in depth at other aspects of the museum experience, such as textual panels, authentic objects, and conversation with their peer groups and teachers. The aim is to discover the motivation behind the students' interactions, both at the time of their visit and retrospectively.

To answer the overarching research question, the role and effect of multimodal technologies is to provide an initial sensory stimulus, shared visual resources, and a platform to introduce the exhibit content and promote positive and accessible opportunities for meaning-making process. They enhance students' engagement with the content of the exhibits. Learning in

relation to this engagement is interconnected, but *learning* and *engagement* are not always synonymous.

Learning here cannot be achieved passively by one simple interaction with a device, but it can be enabled considerably by constant, active involvement with various forms of interaction, whether through playing virtual games, constructing ideas through conversation, question and answer, discovery, participation in a museum activity, or group collaboration. For the students, during their museum visit, it was more important to connect and foster relevance and a purposeful meaning-making process that is readily adaptable to their own language and real-life experiences. Although the type of learning each student experienced depended on the individual, some students connected the museum visit to their schoolwork, some related it to their personal lives, and some admitted that they just had fun with the devices. (This is not to say that even these students did not learn, but rather to acknowledge that a museum visit can result in a wide range of learning outcomes.)

This again suggests that technology cannot provide learning in a vacuum—it must be part of a comprehensively integrated experience, and whether learning occurs depends on the individual's social and cultural background and meaning-making processes. However, multimodal technologies provide the sensory stimuli that enhance students' engagement, and they become more aware of their own learning methods in understanding unfamiliar subject matter through using these tools. This relationship between engagement and learning in museums is also linked to the collaboration and

time contribution between schools and museums in preparing students prior to their visit as well as in providing further opportunities for students to relearn what they encountered during their visit. With such collaboration, what the students have learnt may be developed further and encourage lifelong learning experiences.

Chapter 8: Conclusion

8.1 Introduction

This final chapter concludes this study by examining and exploring the relationship between engagement and learning in secondary school students' museum visiting experiences with technology-driven multimodal exhibits. The next section of this chapter (Section 8.2) reviews the highlights of each chapter, including the existing literature, the study's methodology, the context of these two museums, analysis of the data, and a discussion of the research questions. The third section (Section 8.3), discusses the study's general contribution to knowledge and the methodological contribution toward answering the research questions. The following section (Section 8.4) evaluates the study with regard to its limitations, further implications, and possible future directions. The final section (Section 8.5) summarises and comments on what has been learnt from this study.

8.2 Scope and contributions

The chapters of this thesis report an in-depth investigation of the relationship between engagements with museum collections and technology-driven multimodal exhibits, and whether such interactions can be considered as learning, or simply an entertaining experience and engagement. Based on six groups of secondary school students, their schoolteachers, and museum professionals from two renowned museums, the Natural History Museum, London, and the Churchill Museum, this study attempts to understand the different hypotheses of what learning in a museum context truly is. Without

any clear or detailed justification of this concept in this specific context, one cannot assume that every visitor interaction leads to learning.

Drawing from the review of the literature, mainly in the field of museum-based studies and from studies on learning and technologies, this study addresses a number of questions arising from the problems of current theories about offering the most advanced technologies as an instant solution for 'transforming' learning in museums. With increased encouragement to bridge the gap between school and outside-school learning, plus the more prevalent use of technology-driven multimodal exhibits, museums must face the fundamental question of their purpose in the modern world, and what 'learning' really means in this context. This chapter identifies the necessity of a comprehensive exploration of the ways in which schoolchildren interact, physically and conceptually, with technological supports and museum collections. On top of that, it contributes to the emerging literature by clarifying and identifying gaps in reasoning about what concepts of engagement and learning contribute toward our understanding of museum-based learning.

The methodology and context chapters address the identified concerns and research questions drawn from the literature. They demonstrate an efficient and grounded engagement with theory and a detailed methodological approach throughout the research process, which together have generated a comprehensible and valuable contribution to educational research. These chapters provide the pivot point of defining the purpose of this study. The contribution of these chapters is to explain the qualitative approach of using semi-structured, stimulated-recall, and group interviews, document analysis,

and video recording, but they also argue for the importance of combining stimulated recall with observed video data in order to analyse and validate the students' behaviours and thoughts. The focus then turns to the rationale and structure of the research questions, showing how the questions are formulated through multifaceted data-gathering methods, procedures, and data analysis approaches. The highlight of this is the proposed multimodal analysis, which emphasises the practical and representational aspects to illustrate the full 'story' of the students' interactions by using narrative scenarios to analytically contextualise the data. This method contributes a way to understand how learning occurs in this voluntary and informal context.

The findings and analysis chapters regarding the Natural History Museum and Churchill Museum illustrate a micro-level account of six groups of students' social and physical modes of actions and their responses and interactions with the multimodal technologies, architectural space, museum activity, their peer groups, and their perception of learning in the museum in question. The findings show that the students' physical interactions increased with their physical and vocal participation with the multimodal technologies and their peer groups. Through these interactions, engagement was achieved in meaning-making processes, such as observing each other's interaction, reading textual information, navigating the route in the museum, watching a video, and touching replicas.

On the practical level, the digital nature of the technology enables the museums to update and instantly edit the content of the multimodal technologies. One of the main roles of these devices seems to be to provide a

more accessible and approachable learning environment than the traditional text and object display, which is more difficult and expensive to update. Another important characteristic of these technologies is their attribute as sensory stimuli for visitors—they stimulate different modes of communication and provoke further interest and motivation. These engagements provide a foundation and a positive opportunity for students to experience learning. This study aims to further understand the participants' perception of learning in this context in relation to their interactions. The data suggest that learning here is an organic and evolving process of understanding, realisation, and making judgements. For example, the six groups of students were more aware of making judgements and decisions based on their personal preference for new information consumption or assimilating their prior knowledge from school.

This study also elucidates the underlying complexity of learning in a museum through the multimodal analysis of the scenarios and the interviews with the students, schoolteachers, and museum educators in Chapters 5 and 6. The processes of meaning-making are crucial to enabling students to be more aware of their own learning methods and motivated with their peer group in an unfamiliar place. Not every student learns from her visiting experience, as students have varied social, cultural, and economic backgrounds. Also, both positive and negative experiences can occur during students' interactions, which may influence the ways in which they perceive and reflect on their own processes of learning. For instance, if students encounter a technological difficulty or experience something that does not interest them, it is likely that they will stop interacting or pursuing further situated meaning-

making processes. This is not to say that they stop learning entirely, but the effect of the learning may be less meaningful, engaging, and valuable to their personal goals, motivations, and experiences.

It is also important to contextualise the given contexts, settings, and paradigms before advocating advanced technologies as the ultimate cure to 'support learning'. Although the sensory stimuli are provided by the multimodal technologies in this study, they supplement the conventional museum display format and encourage more physical participation and social interaction, which subsequently leads to motivation and further development on the topic presented. Learning experiences in museums are thus socially constructed, and this construction is developed through various modes of interaction. Nevertheless, for school students, it is important that special care be taken to prepare these visitors for their museum experience with background briefings on the topic at school and defined learning objectives at the museum. For the best result, schools and museums must collaborate. This is not to say that learning in museums should always relate to the school curriculum, but that more opportunities should be provided for lifelong learning.

In this thesis, I have sought to be clear about the contribution of this thesis to the field of learning and technology, especially concerning museums and related informal learning environments. This study specifically explores the role of multimodal technology in relation to how schoolchildren learn in museums. In keeping with social, cultural, and political demands, museums have become more aware of providing additional learning support for mainstream education. Many museums invest heavily in the latest

technologies, trusting that these devices will create new avenues of learning enhancement. The outcome, however, is a constant reciprocal loop of technological novelty for the visitor, some interactive entertainment, and social interaction among the visitors themselves when interacting with the devices. But when confronted by the question, 'Can these technologies really enhance learning?' museums must understand what constitutes learning and how people learn in museums in order to determine the efficacy of the devices. This study is one step in that direction.

One of the other main contributions of this thesis is the use of multimodal analysis and interviews, which provides an in-depth, micro-level illustration of the 'how' and 'why' of visitors' interactions with multimodal technology, and its role in students' meaning-making processes. The presentation of multimodal analysis, consisting of the narration of a scenario and separate multimodal data, has been devised to facilitate a thorough understanding of the context. In addition, the semi-structured and stimulated recall interviews allow the observations to correspond to what the students thought at the time. The combination of these methods provides a logical and qualitative basis for assisting museum designers and academic researchers in understanding how the content is perceived and delivered through different forms of representation.

The differences between the Natural History Museum and the Churchill Museum, both in design and in subject matter, result in different visitor interactions. Still, this type of multimodal analysis is well equipped to provide rich and rigorous sets of data, as well as a coherent and comprehensive

perspectival grasp of students' interactions. This leads to the other contribution of the theoretical framework: illustrating the role of multimodal technologies in relation to students' meaning-making processes and their understandings of learning in the museum context.

The results of this study suggest that technology cannot work in a vacuum, and highlight the importance of museums working collaboratively with students on the content of the technology in relation to the educational activity prior to developing or investing in state-of-the-art technology. It should be emphasised that none of this is to say that the students did not learn or benefit from their visiting experiences, as the results suggest that the students had various forms of meaning-making processes, which were provoked by many existing devices and exhibits.

8.3 Constraints and possibilities

There is always room for improvement. As Gardner (1991, p.262) argues, although the word 'constraint' has a negative connotation, this limitation can actually provoke more positive and innovative possibilities. The capacity to recognise limitations leads directly to the possibilities for further research.

The use of multimodal analysis and stimulated recall interviews in this study strengthens the exploration of the ways in which students interact with various aspects of exhibits, providing detailed and comprehensive data and analysis. However, gathering, transcribing, and presenting the data with accuracy is an extremely time-consuming process. This led to the limitation in

this study of only being able to focus on one group at a time instead of simultaneously overseeing and recording all groups from a school. Moreover, selecting and editing the conversations and interactions of each group's visit, and separating and configuring physical body movements, gestures, and utterances, can be a very subjective process.

To this end, although the method used here is beneficial and feasible to replicate, any time restrictions may act as a discouragement. The possible solutions are, firstly, to have more than one researcher examine and match data in order to improve the efficiency and objectivity of the study. In addition, time and labour could be saved by increasing the digital research resources, such as using CCTV or corresponding video and remote audio recording.

The potential for future research based upon this study lies in examining the longer-term impact in fuller collaboration with schools, technology designers, and museums. The results show the possibilities of motivating students to contemplate, reflect upon, and even look beyond their lives in school in the long run. Potentially, there are gains to be made by expanding the age range studied to both primary and secondary school students, which may allow museums to have a longer-term partnership with schools through a more thorough, longitudinal study. Another possibility is to look at the effect of multimodal technologies on specific segments on the population, such as adults as well as school children. Museums are designed for the public—for everyone. As this study has looked at the detailed relationship between multimodal technologies, authentic exhibits, and textual displays, a future study could target, for example, the disabled audience, such

as deaf, blind, or dyslexic visitors. To extend this study internationally, it would also be beneficial to look at foreign language speakers who visit museums, as this may be an unconventional way to explore how multiple modes can assist information communication beyond language.

8.4 Final remarks

This study has set out to explore in depth how students engage and learn in museums with technology-driven multimodal exhibits. It has reflected at length on the research processes, findings, and especially the chosen method—multimodal analysis, which reveals complex layers of interactions and interpretations. Engagement and learning in a museum context are interconnected, and yet they are two distinct concepts. It is essential to have engagement and processes of meaning-making present to support and engender potential learning. This is only one way of exploring this topic, however; there are more possible speculations and potential analyses to perform in order to understand how people learn in museums, and the implications of the rapid pace of development of digital technologies. The present study has attempted to contribute to our understanding of how the museum visiting experience is being developed through increasingly sophisticated uses of digital technologies, and the kinds of engagement and learning that occur as a result. It also contributes to an aspect of the field of learning and technology, as well as to museum-based studies on learning, through the use of multimodal analysis. More importantly, it permits a far deeper level of appreciation of the complexity involved in learning, a feat

accomplished with gratitude toward the efforts of previous studies in laying the foundations and building a sizeable body of work for later researchers to draw on. It also sparks numerous ideas and supports that can be achieved to make learning experiential and engaging for the students. This echoes a point made at the beginning of this thesis: museums and galleries provide lifelong inspiration for learning opportunities. The present study shows that new technologies have a major part to play in that process, but only when effectively integrated into the wider context of how people learn outside the classroom.

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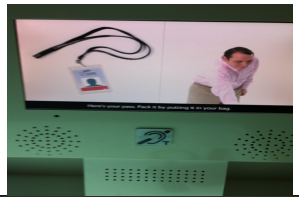
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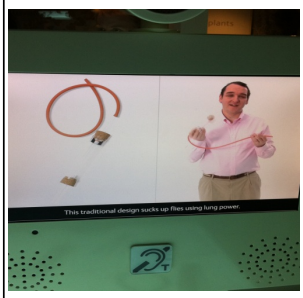
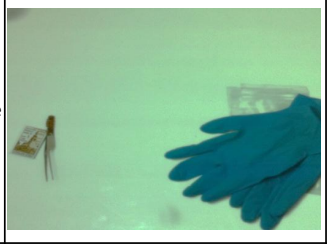
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Appendices:
Appendix A:
Multimodal Transcript for Group A

Multimodal Transcript Group A
Group A Students: Chris (C) Steve (S) and Amy (A)

Time	Participant	Facial Expression, Gesture & Body Movement	Language & Sound	Interactive Device Respond	Image from the device
0.38	Chris and Steve	C stairs at the front screen. S looks at the scanner first then turns back to the frontal screen.		Virtual Instructor is briefing the expedition and explaining about the function of the scanner	
0.49	Amy	A Walks towards the device and looks at the projection table.	A: Why there is a picture poped up? S: It says it's through Scotland.	The Projection table shows a simulation of a file opeing up with images and information about the expedition	
0.59	Chris, Steve and Amy	S turns to C while starts touching the projection table.	S: Ah (.)Rubber flies.	No responds from the projection table	
1.03	Chris, Steve and Amy	C Watches the other two to make decision, S looks up to the projector above to find out the technological machnism. S and A try to reach the same option at the same time.	S: How do we trap them?	Instructor asks user to choose which expedition they would like to choose out of two options	
1.29	Chris, Steve and Amy	S scans the Nature Plus Card.	A: Where are we sacnning it?	Instructor asks user to scan their Nature Plus Card	
1.31	Chris, Steve and Amy	C takes his bag off his shoulder. A leaves one hand on the edge of the projection table and leans her body forward.	A: It's taking a photo of you.	Instructor explains the type of expedition the user has chosen	
1.49	Chris, Steve and Amy	C bends his keen slightly down, looks towards the frontal camera and grinds. S and A looks at C; S laughes and A smiles and realises that C does not stand at the right position for the photograph.	S: Ha (.)Smile. A: Well (.) (laugh) move back a bit (.) You are not line up (laugh)	Instructor asks the user to be ready for a photograph taken for an identity card	
2	Chris, Steve and Amy	C stands up and bends his keen even lower and makes a bigger grind with teeth out. S and A looks at C and laughes even louder. S and A turn to the frontal screen again.		Instructor asks the user to be ready after a count of three	
2.23	Chris, Steve and Amy	C tries to drag it slowly but it does not respond. S and A reach towards the table and touch the card, S succes it at the end.	A:Just tap it, just tap it (.)oh (.) you drag it (.) Oh my God! C: So cool. S: Put it in the bag.	An identiy card appears on the projection table. Instructor asks the user to put the virtual card into the virtual bag.	

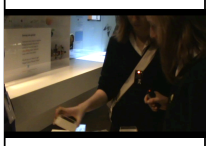
2.33	Chris, Steve and Amy	C just drags one into the bag instantly without a pause. S tries to drag one too but the projector does not react to his respond. A gazes at the frontal screen.	A: Wait, no. no. no. Which one do you need?	Instructor asks what kind of trapping tool does the user need? Three images appears on the projection table.	
2.52	Chris, Steve and Amy	Three people stair at the two images on the projection table.	S: A pooter (.) but what's a pooter? (laugh) C&A: Mechanical pooter (laugh)	Instructor mentions that the scientist needs a pooter to transfer a rubber flies from the net. But would the user prefer to have a pocket pooter or mechanical pooter? Two types of pooters appear on the projection table.	
2.54	Chris, Steve and Amy	C presses the mechanical pooter instantly.		The projection tables does not react at all.	

2.59	Chris, Steve and Amy	C attempts repeatly to drag the mechanical pooter to the bag (although the device reacts fairly slow). S stretches his hand out to stop C and points at the pocket pooter. A tries to help C to resolve the technilcal problem by pressing the mechanical pooter in a different angle. The pocket one reacts to C, hence C drags the one into the bag. A and C frown with disappointment.	S: No. No. No. Just because it sounds better, she might want to keep it in the pocket all the time, in case she finds one while she is on the toilet or something. C: No(.) no (.) yeah well, this one is just as big (the mechnical one). You wanna put it in the bag. We just got the pocket one. A: Oh, look (.) they look so wide. We don't want a long one. S: Yeah we should listen to what the man [instructor] says. C: We have to put it in a bag. A; Put Mechanical on it. C: We just got the pocket one. A: No. Oh.	Touching the image triggers the instructor in explaining the function of the pressed item.	
3.09	Chris, Steve and Amy	C changes his choice to pocket pooter. A tries to help C again.	S: How do we plan them? (laugh) A: Yeah put it in the bag C. Put it into the bag.	Projection table reacts to the choice and allows C to drag the image into the bag.	

3.17	Chris, Steve and Amy	A and C point at the gloves from the projection screen. S stairs at the projection screen but talks towards C. C then points upward to suggest previous exhibit. S pauces then drag the forceps pin into the pag immidately. A strokes her hair to ignore the disagreement. C just gazes at the frontal screen.	C: We need like a box or something. A: And a foam. C: Well (.) forceps with pins. A: Bags (.) we need both. S: I don't know (.) where do you stick the pins? C: In those boxes, you know like earlier on like the mosquitos (the previous device) . S: No (.) no (.) there are only flies, you only do that with little animals (.) they are little animals.	Instructor asks 'how will store a delicate specimens and how will you transfer the specimen back safely?' Two images appear on the projection table. A blue pair of glove with ziplock bag and Entomology forceps with pin	
3.59	Chris, Steve and Amy	A immidately shouts up and points at the Outdoor letter. Both C and S take their time to read. S reads the letter out loud quickly. A waits for C to make the final decision. C drags the outdoor centre paper into the bag at the end.	A: Outdoor. S: hi there, yes we do have acoomodation for you and your colleagues for the Diperists Forum (.) bring this letter as confirmation. C: This mates it cheaper thou (.) cause it can't be too expensive cause they don't get much money, do you? S: Yeah (.)they pay for it! (look at the researcher) They would pay for it (.) it's an all pay trip. A: No room (.) so you have to use the mat and the bedding so I want the lab in the gym. C: Go on. S Yeah (.) yeah.	Instructor asks what kind of accomodation the user would choose, Piper Guesthouse or Outdoor Centre Gym. Two images appears on the projection table. A letter regarding the guesthouse and a welcome letter from the outdoor centre. When C presses the Outdoor Centre, the instructor gives advice on the cost and the availability of the room with . C then presses the Guesthouse to hear more about the option the Guesthouse provides.	

4.29	Chris, Steve and Amy	S shouts out the term that he has named the type of clothing. C smiles and let S to drag the image into the bag. A tries to pause his decision by pointing at the frontal screen and analyses the situation again. C then turns to A and explains the type that she refers to is the same as S's devision. S drags the image into the bag.	S: Really (.) Indiana Jones. C: (laugh) Indiana Jones. A: Wait (.) we are going to Scotland. C: Yeah. S: That's Indiana Jones (refers to the long trouses with hat). A: Well, there is going to sun burn if you go to Scotland. C: We don't want to wear T-shirt to go to Scotland, do we? A: Yeah (.) okay we don't want to be bitten.	Instructor asks what kind of clothing they should pack, whether it should be long clothing or short clothing. Two images appears on the projection table. A insect protected clothing and T-shirt with shorts.	

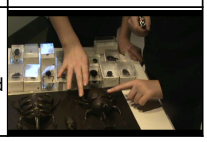
Appendix B:
Multimodal Transcript for Group B

Multimodal Transcript for Group B			Total Time: 06:57-14:30			
Group B Students: Charlotte=C, Emily=E, and Museum Educator Jill						
Time	**Participant**	**Facial Expression, Gesture, & Body Movement**	**Participants' Language & Sound**	**Museum Educator's Facial Expression, Gesture, & Body Movement**	**Museum Educator's Language & Sound**	**Supporting Visual Data**
06:57	Emily and Charlotte	Wandered around the interactive screen area and gradually walked toward the stall. They stopped in front of the stall and started touching the specimen boxes. E started pointing at one box and turned to C.	E: Oh, nice colour. C: Yeah. E: I like that one.	Turned away to clear her throat and observed the two girls' body movements with the specimens.	Yeah, I was just thinking about the possibility of selling the pretty ones in the shop. But then I thought they are...were living animals. Probably wouldn't be quite...really tasteful.	
07:00	Emily and Charlotte	Looked at Jill then looked down to the boxes again. C touched one of the green specimens in front of her.	E &C: Laugh. C: Yeah, I like the colour.	Observed what the students were interested in, leaned both her hands on the stall. Looked up at both students' faces.	Now that's a chafer. Now, the activity is to try and put these beetles in the four groups.	
07:29	Emily and Charlotte	E turned to C with confidence and smiled.	E: Like the one we did over there. C: Yeah.	Looked directly at both students' faces.	Yep. So you've had practice now. Now, I've got a group range from one to five. Then it's the four groups.	

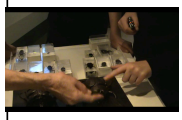
07:51	Emily and Charlotte	E started to pick up two boxes. C pointed at one on the stall. E put one at one corner while C picked up another one and turned it sideways.	C: That's the water one. E: Is it? C: It's the one over there. E: Yes...and it goes with that one...do you think? C: Cause that one has got legs. E: No...they have got legs, but that one's leg is just underneath.	Leaned backward to let them sort out the categories. Frowned when she found they were not making the right categories. Turned to E and took E's box at the top corner.	So let's just stick this at the corner then...so you can find any other you think that might go with it.	
07:57	Emily and Charlotte	C picked up another box and put it with the top corner box that the museum educator located.	C: That one. E: Yes...	Smiled and looked at the other boxes.	Yeah.	
08:00	Emily and Charlotte	E picked one box and left it at the opposite corner of the other boxes. Both of them stopped when Jill spoke.	E: That one. That one hasn't got very long one than the other one (mumble). C: That one...	Leaned back and looked at the box that E picked.	Remember, sometimes bits get broken.	

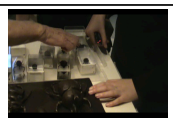
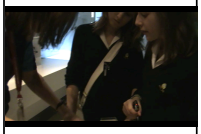
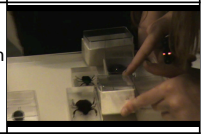
08:12	Emily and Charlotte	E spent most of her time looking at two boxes. She also pulled one of her arms up when she mentioned wings. C spent most of her time sorting and looking at different boxes. C laughed when E pointed at one box and mentioned the word 'disgusting'.	E & C: Yeah. E: That one has got wings. C: But that's just out. But they all have wings. E: Yes. These ones do. They are just fold up, like ladybirds. C: Do you think these ones... E: Er...that one is disgusting. C: (Laughed) It's got like a horn.	Puts her hands back and watched the two students' make their decision.		
08:19	Emily and Charlotte	C picked up one box, looked at it, and passed it to E. She wanted E to have a look at it again. Once E commented on it, C took it back and put it on the stall with other boxes. E picked up another box and put it at the corner with another box.	E: Yeah. C: That one. E: Yeah. C: That one. E: Yeah. I think that one would go with the ones...oh no, it wouldn't, cause that one is one of the ones put these things in...like elbows in plants. Put those two together. C: Really? I thought that one and that one, cause it's, like, got the bulging things and then... E: Yeah, but they both have got, like, the horns from that bit there. C: Yeah.			

08:36	Emily and Charlotte	E picked up two boxes and showed them to C. She then grabbed another one in her hands. Both of them constantly picked up boxes to see and compare them.	E: So is that one. C: That one might have... E: Yeah. So put these three together. C: So put these two together cause they got, like, the thing... E: Yeah.	Frowned first, and then pushed two boxes to one corner of the stall and pushed the other two at the other end of the stall.	So put these two into that corner, these into this corner.	
09:03	Emily and Charlotte	E tapped at the five groups they created, then turned to C.	E: One, two, three, four, five...we have got five groups, Charlotte.	Put her arms on her waist.	I know...so something is…	
09:05	Emily and Charlotte	C started to reorganise the boxes by picking and pushing one or two boxes to another corner. E looked up to Jill to see her reaction when C was rearranging the boxes.	C: So these two go... E: So you are only allowed to have four groups.	Stretched one hand out among the boxes.	There are only four groups. This is why it's so hard to be a scientist to actually classify...	
09:13	Emily and Charlotte	E and C tried to reconfigure the groups again.	E: I think that one might go with these…	Put her hands behind her back.	Yes. That's right. Those three are right.	
09:18	Emily and Charlotte	C picked up two more boxes from the stall while E moved one to the other side of the stall.	E: These…	Reached her hands out to help. Pushed two boxes to one side and one to the other.	Just put that one round there, you can put those together there…	
09:21	Emily and Charlotte	E touched a box while C grabbed another box.	C: I think you can put that one…	Pointed at E's box.	Yes. That one has broken antennae, so that one belongs there, so you have got…	

9:37	Emily and Charlotte	E picked up the one that Jill mentioned and put it in another corner while E slowly put the one in her hand in the other corner. She then tried to describe the horn by putting her palms together to form a horn shape.	C: This one would go over with this one. E: And this one... C: I think... E: Yeah, that one has got a horn. There. C: It can go with this one.	Put her right hand out and left hand on the top-right corner.	Okay, right...so...why did you put these together?	
09:45	Emily and Charlotte	They both looked surprised. E put her arms on her waist.	E: Oh!	Smiled and put her hand on the left-hand corner and looked up at the two students. Started to reorganise all the boxes again.	Yeah...okay, in that case...that one is the diving beetle, with the streamlined body. And this shows you how hard it is to classify things...the only absent one is the only one. Now...let's put that one in the right group...and that one into the right group. Now, in this little group, you have got what?	
10:03	Emily and Charlotte	They both reached out their hands and pointed at the boxes.	C: Beetles with the legs. E: The longhorn.	Pulled out three boxes.	That's right. These are the longhorn beetles and long antennae. Right...things, group, you said, with a various thing, like a long whatever...	
10:20	Emily and Charlotte	C pulled her left elbow out and tried to describe her point.	C: Long elbow joint...apparently.	Picked up a box.	Yeah...it's got the long snout.	
10:28	Emily and Charlotte	E used both hands to draw a square shape in the air.	E: And then the two long things coming out of it.	Picked up the box with one hand and pointed at it. Asked the antennae question while holding her arms up to imitate.	That's right. And that's called arachnid. And a lot them have got their antennae like this. Did you know why?	

10:33	Emily and Charlotte	Looked at the box that Jill picked up. Both of them kept their hands on the replica models in the stall.	E: No. C: (Laughed)	Constantly pointed at the box but also touched the surface of the plastic replica of the beetle. When she described the movement, she tried to animate the replica with her other hand.	The reason is the females bore into plants. And then they turn themselves around and they stick their egg tube into the plants. Lay their eggs...then develop their eggs into larvae, then into pupae...larvae cause the plant... Now, to make that hole...she has to have that long arachnid, and antennae get in the way, so we have got these antennae right up by the head...the joints just fold right by the head	
11:00	Emily and Charlotte	E looked at Jill.	E: So that's how they adapted?	Smiled and nodded her head.	That's how they adapted.	
11:03	Emily and Charlotte	C put her right hand under her chin.	C: Oh...I get it.	Put her right hand on the other corner of the group. She used a finger to point out the snout area.	Now...that's a very difficult group because this one you put in, there...you can see, it's got a snout pointing downwards.	
11:10	Emily and Charlotte	C tried to imitate the snout by raising both of her hands and pointing downwards. E tried to point at the box.	E &C: Oh... E: That one is pointing upwards, though.	Put the previous box on top of another box and pushed it aside. Pointed her finger at another group.	Now, that one is slightly different. Let's look at that group in a minute... This one is a weevil...it lives in the Namib desert...and you can hardly see very much of a snout. So they are what we called a very diverse group.	

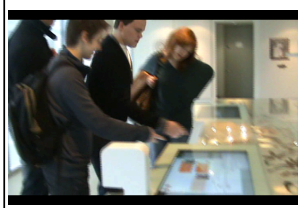
11:36	Emily and Charlotte	Both looked at Jill with full concentration.	C: Oh (laughed). E: Oh yeah. C: Mm...	Constantly looked at E and C's faces and looked down to the box while use a finger to point at the specific features in the box. Occasionally imitated her description by putting the box down and using her hands and body to suggest the shape. Pointed at the large replica of a plastic beetle model and used her hands to touch its surface.	Okay... They actually squeak...we have actually got scientists researching them at the moment...and they can scrape their back ends with their legs and make a squeaky noise. Now, this is a group called 'scarab beetles', feel the legs. Now, this is a scarab beetle. And they have got these very rough legs...	
12:00	Emily and Charlotte	C tried to imitate Jill by touching the surface of the model's back. E tried to touch the horn of the model.	C: Yeah. It goes like that at the back. E: All of them have the horn.	Put her hands on her waist again and allowed the students to touch the model.	Yes...like an armour. You see this, the horn here…	
12:08	Emily and Charlotte	C touched the model's antennae while E answered the question.	E: Is it because they live in a different place?	Pointed at the box.	Yes, that's right. Now, why doesn't that one have a horn?	
12:12	Emily and Charlotte	C stopped touching the model, turned to Jill, and answered the question. E looked at the box.	E: They... C: Was it because of that top? E: They hunt differently? C: Maybe… Isn't...erm…no...erm...	Picked up the box and pointed at the specimen.	Could be? I'll tell you that it's the same species as that one. Now…	

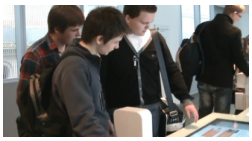
12:30	Emily and Charlotte	E pointed at the larger model and then the smaller model. She then looked up to Jill.	E: Is it that one eats bugs and one eats other smaller animals?	Pointed at the box, then the model.	One is big and one is smaller. What do you think the difference between them is?	
12:40	Emily and Charlotte	C left her hand on the larger model. E followed what C did.	C & E: Oh…	Pointed at the box again, then the model.	No...that's the male...that's the female.	
12:43	Emily and Charlotte	Both stopped and looked at Jill's body movement, but they kept their hands on the model.	C: Yeah.	Pointed at the model and then tried to imitate the horn with both of her hands. After explaining about the beetle, slowly left her hands on the stall again.	That's a Thai Fighting Beetle, and this one is the Rhino Beetle, but it does the same thing, and it's only the male that has horns cause it's only the males that fight. And in Thailand and in Japan, they put bets on the male beetles that will win the fight. It doesn't seem to do them any harm, so...and if you want to see the fight...you would want to get to YouTube, and you will be able to see it...	
13:00	Emily and Charlotte	C kept pointing at the surface of the boxes while Jill was talking.	C & E: Yeah.	Pointed at the boxes again to show specific areas.	So...they all are in this group because of these parts of the spiky legs...and the males often have horns as to females. See that? It's got a tiny horn.	
13:22	Emily and Charlotte	Both of them pointed at one box each.	E: The wings. C: The wings.	Smiled and looked at both of them.	And now...what's poking out on this?	

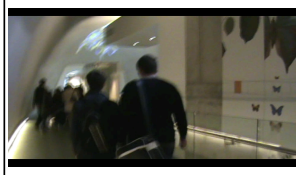
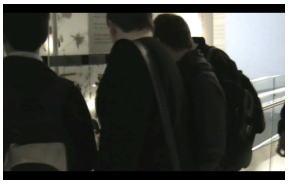
13:26	Emily and Charlotte	E opened up her arms to explain the wings. C tried to imitate E at the same time, but she stopped after two seconds.	E: Opens. C: Opens like that. E: Case. C: Inside the case, it opens like that and it flies.	Tried to explained with both of her hands, then picked up a box and showed it to the two students.	Yeah...so what happens with beetles is they have a very hard set of wings making the outer case, and inside they have the wings they fly with. So have you seen the ladybirds fly? What does she or he do?	
13:43	Emily and Charlotte	Both looked at Jill.	E: Oh.	Moved the box closer to the students and then pointed with her other hand to the model to show the similarity.	That's right...and what's amazing is they are as big as this. They can actually fly. They don't fly that often, but they can actually fly.	
13:53	Emily and Charlotte	E looked directly to Jill. C picked up another box to explain her point.	E: No! C: The legs?	Asked with a smile.	Do you know the parts of an insect?	
13:57	Emily and Charlotte	E pointed at the different part of the model slowly.	E: Arms, body, shell.	Smiled again and put her hands together.	Yep...okay.	

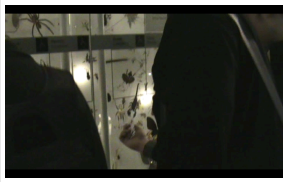
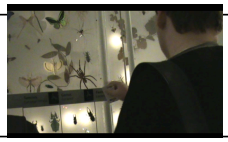
14:00	Emily and Charlotte	Both smiled.	E: Okay. Thank you! C: Okay! Thank you!	Pointed at the replica's wings, abdomen, head, and legs, in accordance with her utterances. Looked at the two students occasionally to check if they were listening.	That's its wings there...now, this is the underneath of an insect. That bit there is called the abdomen. You have got an abdomen...this bit from there to there, it's got its legs and wings on it, it's its chest, called the thorax. You have got the thorax there. And then it's not always easy to see their head, but you can see it's got its mouth part there, so that bit is the head. So it's got three body parts. You have got the abdomen, chest, and the head, and six pairs of legs.	
14:30	Emily and Charlotte	Turned to Jill and smiled. They both then waved at her and kept walking toward the next station.		Smiled and put her thumbs up to the two students.	(Laughed) So you did very well on that, indeed.	

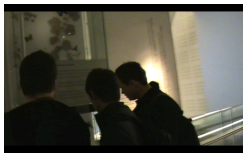
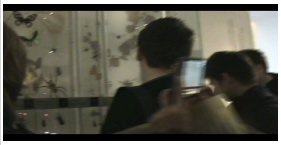
Appendix C:
Multimodal Transcript for Group C

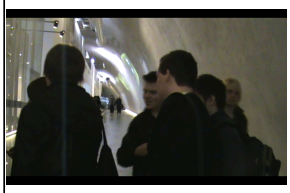
Multimodal Transcript for Group C					
Group C Students: Alex=A, Nathan=N, Roger=R, Tom=T, Jason=J. Schoolteacher=Beth (B)					
Time	**Participant**	**Facial Expression, Gesture, & Body Movement**	**Language & Sound**	**Interactive Device Response**	**Image from the Device**
Scene 1	Alex and Nathan	Both A and N quickly exit the lift and enter the beginning part of the Cocoon. N steps backward and looks at A.	N: Wow-oh, Alex.		
01:34	Alex and Nathan	N turns to A and passes him his bag. He then takes his jacket off.	N: Can you hold that for a second? Here you go. Cheers.		
01:49	Alex and Nathan	N looks at A, both of whom are walking toward the device. He arrives at one of the devices while A rushes to follow.	A: Alright. N: Go on! Go on! Sort it out!		
02:00	Alex and Nathan	N begins to touch the screen and selects an option. He then reads out the text from the screen. A later points out a message indicating that the device is out of order.	N: So what are we doing, mate? Ah, now this is pretty cool, actually. So, stand by the specimens. A: There is a message.	At first, the screen appears to have two options. It later appears to be out of order.	
02:24	Alex and Nathan	N looks at A and points at the device, explaining the function of the device. A tries to scan the Nature Plus Card but keeps having technical problems, so N keeps asking A to scan the card in different ways.	N: Ar...Look at that, err...Maybe not. A: Ar...This one, this one works. N: So, it says what item you want to collect. Scan your card. No! no! Touch and continue, select your favourite item. Scan your card. So, scan, scan the card. Scan this, Alex...Scan these, yep.	The screen appears to have two main options again. It keeps returning to the main page.	
03:00	Alex, Nathan and Beth	N calmly looks at A then reads the screen after explaining A's mistake. He later looks at the images from the touch screen device and digital specimens. He then moves towards their teacher. B turns around and moves away from her device.	A:It isn't working. N: Wrong way. Yeah (.) It says the item you want to collect...It's not on here, though, is it? Could we just have a look, miss? B: Course you can.	The screen appears to have two main options again. It keeps returning to the main page.	

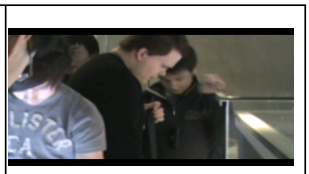
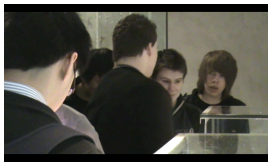
04:28	Alex and Nathan	N scans the card at a similar device and selects from the device. Once it works, he turns around to A and B. A watches how N navigates because his device is not working like N's. N tries to help, pointing at A's screen, and after a while, both of their screens work.	N: That's quality. Have a look at your data, once you have selected your data…That's cool, miss!…Yeah, that one is not working. I think we actually have to store and scan it first. A: Shall we just scan everything? N: No, no, just get the one that you want. So let's just finish this...now click on that one and then click on that one afterwards…This is good, actually! Really interactive!	The screen appears to have some simulation and four options to choose from. Once N presses one, it brings out another simulation and some textual information. It asks one question and gives options for N to choose. Once N does so, it gives out a line of answer.	
05:11	Alex and Nathan	A looks at the image and textual option and turns to N. N also finds something on his screen, so he turns back to A and tries to instruct A on what to do. N then asks A a question when A nods his head to agree.	A: Not doing this! Not doing this...et to it! N: Now actually, I quite like about this that it's interactive, so it's not like reading or telling you about something or someone telling you about something. A: So you put your card into this. N: Wow-oh, that's really interesting, like this. Get this bit of information...So it's all about identification, so. I like this display, don't you?	The screen asks if the user wants to store the information on his card. Some simulations of bees and graphic works are happening at the same time.	
06:18	Alex and Nathan	A keeps scanning and selecting. N touches the selection on the screen, looks around at other students, and realises that they are gazing at his screen, too.	N: It has got more of the visual interaction, and actually the physical as well. I wanna see that. Now, this is cool. I have read that bit. I actually want to read about the honeybee.	The screen appears to have more images of the bee and other related insects with a couple lines of explanation.	

Scenes 2 & 3 13:06	Alex and Nathan	A and N walk away from the previous device.	N: I was trying to see if I could find out about that one. A: Nah. N: Yeah, I don't even know why they are walking along so fast. A: Cause it's about plants! N: But I still think it's still quite interesting. A: Yeah, but a lot of the people don't. N: I am not saying that, Alex.		
14:34	Alex, Nathan, Jason, and Roger	N points at the glass cabinet and smile. A points at the spider while trying to see what J and R are looking at. N turns to Jason with a grin. R leans his shoulder on the glass and points at the centipede. A looks up at where R is pointing.	N: Now this is more your kind of thing. A: Now this is...Yeah, ar...look at the spider. N: Or, I tell you what, if that ran across my living room... J: What is that? R: There is a centipede round there as well. A: That's a centipede.		

14:47	Alex, Nathan, Jason, and Roger	N shouts out while trying to go toward the specimen. He asks R and points at the specimen while frowning. R turns to N with a huge grin on his face and points his finger toward N to mimic a broken finger. J points his finger at the glass. N steps back a little and keeps frowning.	N: Flipping hell...Can I have a peek around it, Roger? Cheers. R: Sure. N: Thanks, Roger. What the hell is that? J: It's a centipede. R: It would rip your fingers apart! N: I know that, but I am flipping out! It's quite a thingy, isn't it?	Five spotlights appear on five species as J touches the glass.	
14:50	Alex and Nathan	A keeps pressing the glass with his finger. He stops as N decides to touch the 'press area' on the glass.	A: Why is it not working? It's not working! Oh, here it is. N: Okay, it does, you just touch that. You what...	The lights would not come up when A tries to press it. It lights up as N touches it.	

14:58	Alex, Nathan, Jason, Tom, and Roger	R turns to both N and A while pointing at the glass where the specimen is. N turns to R, then turns toward the glass again. A puts his hand in his mouth for a couple of seconds, then puts his hands into his jeans pocket. N turns to A while R turns to J and smiles. [WHO?!?]tries to press different lights to find out which lights go with which specimens.	R: If you just look at its jaw, it's quite black and... N: You what? Look at its jaw? Woooo... A: I wouldn't want to be bitten by that. Oh. (Laughs) R: It's probably quite poisonous as well. (Laugh) J: It's probably quite painful. Haha… N: It is a centipede? Yeah, oh, Alex, didn't we see that before? Not like in real life but when we were in... R: They would rip your fingers into pieces.	Once R presses the screen, different lights come up at different times as he presses.	
15:03	Nathan and Alex	N turns to A while putting his right hand on A's shoulder. A looks aside and tries to remember. He frowns, then smiles after a few seconds. N looks excited and starts walking toward the next exhibit. A follows N.	N: That's what we were trying to remember the other day, wasn't it? A: Final class, wasn't it? That's what we had look at. It's different kinds of species. N: Saw that one the other day, do you remember? For grades. A: Yeah.		

15:25	Alex, Nathan, Jason, and Roger	N looks around and speaks to both A and R. A walks toward another group, as he is trying to find out what the other group is doing. N stares at the large model of the mosquito while R points at the model. J turns to both N and R to ask a question. N reaches his hand towards A's shoulder. A turns around and tries to answer. J continues to speak out loud without looking at any particular person.	N: It's really good in here, actually, it's generally good. R: Wow-oh! J: That's huge. N: That's pretty insane. Massive! R: What's that one with the large spike on this head? N: Alex, what's wrong with the huge spike on the top of his head? J: That's ridiculous! The antennae at the top! A: Er...I know it, er... N: I think you told me that one before. Isn't it like to flick things over or something? R: To snag. A: It's to stab people. N: Is it? J: I wonder why it causes so much damage.		
16:00	Nathan and Alex	N stares at the mosquito model behind the glass while speaking to A. A brings up his card and looks for the scanner. N points at the other side of the exhibit.	N: That's twenty-eight times the size of it. Isn't that why in Dubai, if you have a pond or something, you would have to put a net over it to get mosquitos, otherwise they would try to get into it? A: Is there a scanner? N: There! It's down there.		

16:25	Nathan, Alex, and Jason	J stands next to N and points at the model. N continues pointing at the glass where the textual display is. A looks down at the text and tries to read it while N is reading it out loud.	J: This is the biggest that I have seen. N: Yeah, it's huge. So… N: Yes, see look Alex, by removing larval habits (.) by pulling out reeds from the edges of rivers flowing through villages. That's the thing of what they have from the other one. A: Yeah.		
17:07	Nathan and Alex	N and A both looks at the model and try to read the text at the same time. A leans against the glass cabinet, frowning. N points in the direction of the text while A leans his elbow on the glass cabinet.	N: That's a male. No, compare with the other model...sorry, so...wait, that's not that one there. So this is a female and that one is a male? A: No, I think they are different species. N: Are they? I think they are just in different sizes. Yeah, I think...No. I think this is an *Anopheles*. And that's a female. A: That's a female. N: Yeah, so that's the one that actually transmits it. A: Yeah.		

Appendix D:
Full Text for Group D Scenario

Once all the students were sitting down in the learning centre, the museum educator, Sandra, began by asking them to pair up, start gathering ideas, and write on the whiteboard table what they considered to be the two most significant characteristics of a strong leader. Chelsea turned to Dominic with a smile and said, 'You have to be reliable.'

'Definitely, confident,' he replied. 'Because confidence, it's a bit, because you have to be confident in what you are choosing about.' He spoke while still texting on his mobile phone.

Chelsea began to write on the table with the whiteboard pen. 'And being confident means you are a good speaker. I think confident and reliable. Confident is a root of most of it,' she further asserted as she circled the word with a line drawing of a cloud.

'Reliable.' Dominic stopped texting, nodded, and looked at her writing.

Chelsea carried on writing other characteristics on the whiteboard while speaking slowly. 'Confident in the…'

He cut in, 'It has all of these things in it, yeah.' He paused a few seconds and continued, 'Because without confidence you can't speak to anyone.'

She nodded. She put her pen down and added quickly, 'And morals, yeah, society will affect your morals, you know what I mean, because you would be different than everyone else,' then continued writing on the table.

Dominic rested his left hand against his chin, slowly slipped his phone into his right pocket, and looked at Chelsea. 'Confident, yeah, and so brave, being brave is also courageous minded.'

'Yeah, confident, yeah, and being reliable makes you, like, for the people, and it makes you willing to share ideas, and it makes you tactful, because you have reliable ideas, so reliable and confident, yeah. And it makes you opinionated, your confidence, because you will be able to share those ideas.' She replied to Dominic's statement with a frown.

'Yeah, confident and reliable. And you are not careless,' he emphasised as he began to rest his elbows on the table.

'And it makes you opinionated. Yeah. It makes you brave as well. Being confident and reliable leads the way for everyone, really.' Chelsea seemed more confident as she smiled and commented.

Dominic looked down to the table and leaned against the wall as he realised that they had to narrow their choices down. 'Yeah, confident and reliable. Yeah. We have got so much, so it's hard to choose.'

'There are so many things that you should be as a leader,' said Chelsea. 'What happened to strong minds? You can be confident and reliable, but it doesn't necessarily mean that you have a strong mind.'

'Yeah, you have to be so many things. So, confident?' Dominic asked as Sandra began to brief them about what they were going to do in the digital room.

'What we are going to do next,' she explained, 'you are going to need to try and find some evidence to see whether Churchill fits into those

expectations, much of those expectations of what you think a strong leader should display and what you think a strong leader should be like. You are going to do this by looking for evidence in the Churchill Museum, to see if you can find things that match up with Winston Churchill's ideas about the leadership that match up with things that support or contradict him and the way he displayed leadership skills' (see Appendix D for more detail).

Later, after the briefing, the two students along with the rest of the class entered the museum and began by quickly browsing some textual panels and authentic objects with other students from the other groups. Dominic began to look at authentic exhibits in a glass cabinet, but when they stopped at one of the textual panels, he asked Chelsea, 'What were your two words that you…?' 'Confident and reliable,' she drawled, facing the panel. Soon afterwards she tried to clarify her statement: 'And the most, confidence, not reliability. Yeah, but I think that if you are confident and reliable as a leader. And it shows, like, other values, because we wrote a lot of things like strong-minded, opinionated, you have the confidence to be that.'

'That might include other things,' Dominic muttered.

Chelsea noticed that he had less interest and so began to ask more questions to provoke him. 'And the reliability sort of links some of those things as well. Yeah, so where do you think you might look to find one example of him being reliable, that is going to be tricky.'

'Probably in the war, maybe,' Dominic replied while still browsing other cabinets and textual panels.

'Yeah, yeah, maybe where he was quite good at that because he says he is going to do something and then he does it. Right, because he worked through the coalition. Maybe we should take a picture of ourselves. My microphone thing keeps slipping. Where is everyone?' Chelsea looked at Dominic and began browsing other exhibits heedlessly.

'They are outside,' said Dominic. 'He always has a cigarette in his mouth. You should take a picture of that whole cigar thing,' he replied while pointing at an artefact in a cabinet.

'They made him a dog, oh. Did you know that the Churchill dog, was it named after him?' she exclaimed, looking at the same cabinet. She pointed at the little ceramic miniature of Churchill's head with a dog's body.

'It might be, you know, actually,' he replied, looking at her as she turned towards their schoolteacher, Steve.

Chelsea asked, 'Sir, you know the Churchill dog, for the Churchill in that advert, was it named after him?'

Steve smiled and quickly replied while rubbing his palms against each other, 'Yeah, which is weird, because now when you Google "Churchill", you get these insurance options and it kind of taints the name a little bit.'

'Uh-huh.' Chelsea smiled, but all of a sudden, she stepped into a sound sensor device.

Dominic whispered at her, 'Well, this'—pointing at the two audio devices—'happens when you walk in front of it.'

'I know, I was quite scared!' Chelsea yelled.

Steve looked at the two students and asked, 'So, what are the two features you are really looking for?'

‘Confident and reliable,’ Chelsea immediately said.

Dominic smiled. ‘Confident and….’

Steve smiled and looked at the Timeline table. ‘Oh, okay, confidence and reliability. So you have got Soviet and the other thing? This is hard. He builds confidence by doing a lot for his allies, for some of the countries that they were allies with before in the war.’ He then allowed the two students to discover for themselves and disappeared to another part of the digital room.

Both students then began to walk toward the Timeline table. Dominic paused at a picture of Churchill and said, ‘Hmm.’

Chelsea pulled up the museum-given camera and turned to Dominic. ‘Take a picture of me next to his picture, because it would look funny innit. Hold on.’ She posed as Dominic took a picture of her and smiled. She then looked down at the Timeline table and tried to touch the projected images on the table, and said, ‘Wait, let’s look for dates to see if he was reliable. Because if he said he was going to do something, in his, like, manifesto to be the Prime Minister, then he should of have, erm, like.’

Both of them looked at the table and began to play and figure out the function of the control bar. ‘It’s like a folder, isn’t it?’ Chelsea remarked, surprised, as Dominic continued to play with the strip bar alongside the table. ‘When was the date that he became like Prime Minister?’ she asked.

‘It was, like, 1940, you know.’ Dominic turned his head toward her as Chelsea turned toward Steve again as he walked past.

‘Sir,’ she asked, ‘do you know when Churchill became Prime Minister for the first time, because we are trying to look for his reliability in his, like, manifesto.’

Steve rubbed his hands. ‘Yeah, I think it’s about 1940, I think, the war had just started and there was a Prime Minister, Neville Chamberlain, and so yeah, May 1940, Churchill becomes Prime Minister.’ While he tried to open the digital file, he murmured, ‘How does this work?’

Chelsea spoke out loud while trying to operate the files. ‘You touch that—ah, what is it doing? Yeah, it’s on the wrong one. Okay, I am trying to, okay. What’s it doing? It won’t open. This is so confusing. Try it, try to go that way? We need you. It is not opening. My gosh, okay, we are trying to look for reliability resources. We can’t find any. Oh. Okay, I think I managed to open. What have I done?’

‘Yeah, I think you just hold it on it, and it will open.’ Steve finally figured it out and turned to the two.

‘Yay! Oh, my gosh. May. It went down there,’ said Chelsea.

‘It is down there. And if you got to match the events that happened.’ Steve quickly turned to Chelsea as he was being called away by other students.

‘We are trying to look for this here. It keeps opening and not opening,’ said Dominic, signalling to another schoolteacher, Jason, as he happened to be nearby.

‘Which event are you looking for?’ Jason asked.

‘May 1940, because we are trying to look for reliability in his manifesto when he became Prime Minister,’ Chelsea quickly answered with frustration in her tone while holding her clipboard.

‘It is May 1940,’ Jason firmly asserted, looking down at the digital file and pointing at the particular event date in the file.

‘Yeah, we are trying to open it,’ Chelsea impatiently moaned.

‘Okay, May 1940. You can probably get it down here.’ Jason pointed at where the 1940s are.

‘It is somewhere down there,’ Chelsea said as Dominic tried to open the digital file again.

‘Yeah, that is when they were in Italy.’ Jason pointed out another file and got called away by a student from another group. He walked away as Chelsea continued looking at the file.

‘I can’t use this,’ she said. ‘Let’s see, Mussolini, you could say that it shows reliability because he was helping his country, really.’

‘Helped defend a country,’ Dominic repeated while trying to help Chelsea open another file.

‘Defend, yeah, defended country. When was that? September 1940. Should we move, because this thing is not helping, because it is not opening properly. It is doing it by itself now. Let’s look for more. Oh, look. How do you, do you touch it or something? That is very cool. American relations with Roosevelt. I think that was when the Depression and everything was. Yeah. After, it was the aftermath of it, because I remember 1930, Roosevelt,’ Chelsea said as she opened the other files and tried to read them.

‘So, Stalin,’ Dominic said quickly.

‘That shows he was a nice person,’ she replied.

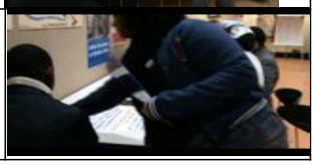
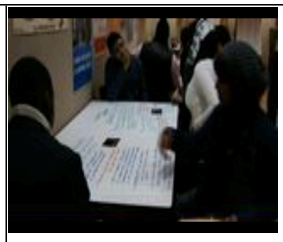
‘Uh-huh,’ he agreed.

‘Dictator, clears up misunderstanding. That shows he is a nice person. He went all the way to Moscow to clear up an understanding, misunderstanding,’ Chelsea explained to Dominic.

‘Hmm, yeah, after,’ he agreed again.

Appendix E:
Multimodal Transcript for Group D

Multimodal Transcript for Group D
Group D Students: Chelsea (C), Dominic (D), Steve (S), Sandra, and Jason (J)

Time	Participant	Facial Expression, Gesture & Body Movement	Language & Sound	Museum Educator's Responses/Timeline Table responses	Still Image of the Moment
5.23	Sandra, Chelsea, and Dominic	D has his head down, as he is texting on his mobile phone underneath the table. C faces the museum educator. Sandra looks at all the students and points at the posters occasionally.		Sandra begins to explain about the museum and briefs them about the activity in which they are going to participate.	
7.01	Chelsea and Dominic	C turns around to D, then turns back and smiles at Sandra.		Sandra begins to explain about the museum and briefs them about the activity in which they are going to participate.	
7.15	Chelsea and Dominic	C begins to write ideas down on the whiteboard. C makes further insertions as she circles the word with a line drawing of a cloud. D looks at what C writes down while texting underneath the table.	C: You have to be reliable. D: Definitely, confident. Because confidence, it's a bit because you have be confident in what you are choosing about.		
8.01	Chelsea and Dominic	C carries on writing. D stops texting, nods his head, and looks up to see what C is writing.	C: And being confident means you are a good speaker. I think confident and reliable. Confident is a root of most of it. D: Reliable. C: Confident in the… D: It has all of these things in it. C: Yeah. D: Because without confidence, you can't speak to anyone.		
8.05	Chelsea and Dominic	C looks at D while she is speaking. She then looks down to write the word 'moral' on the whiteboard. D pauses his texting.	C: And morals, yeah, society will affect your morals, you know what I mean, because you would be different than everyone else. D: Confident, yeah, and so brave, being brave is also courageous-minded.		
9.45	Chelsea and Dominic	C puts her pen down and looks at D. Then she picks up her pen and continues writing. D rests his left hand against his chin, slowly slipping his phone into his right pocket, and looks at C.	C: Yeah, confident, yeah, and being reliable makes you, like, for the people, and it makes you willing to share ideas, and it makes you tactful, because you have reliable ideas, so reliable and confident, not...yeah. And it makes you opinionated, your confidence, because you will be able to share those ideas. D: Yeah, confident and reliable. And you are not careless.		

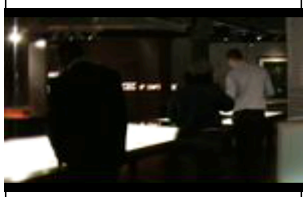
9.49	Chelsea and Dominic	C smiles at D as she speaks. D rests his elbows on the table.	C: And it makes you opinionated. Yeah. It makes you brave as well. Being confident and reliable leads the way for everyone, really. D: Yeah, confident and reliable. Yeah. We have got so much, so it's hard to choose.		
10.03	Chelsea and Dominic	C stops writing and looks down at the whiteboard table. D rests his left hand against his chin while asking question.	C:There are so many things that you should be as a leader. What happened to strong minds? You can be confident and reliable, but it doesn't necessarily mean that you have a strong mind. D: Yeah, you have to be so many things. So, confident?		

11.12	Sandra, Chelsea, and Dominic	Both students stop and turn towards Sandra.		Sandra: What we are going to do next is you are going to need to try and find some evidence to see whether Churchill fits into those expectations, much of those expectations of what you think a strong leader should display and what you think a strong leader should be like. You are going to do this by looking for evidence in the Churchill Museum, to see if you can find things that match up with Winston Churchill's ideas about leadership that match up with things that support or contradict him and the way he displayed leadership skills. And you are going to take some paper and pencils because I couldn't even find any pens this morning, and you will just get paper and pencil. You also get this, which has a map of the museum. The museum is not laid out chronologically. It is laid out thematically. And if you look at the map, you will be able to see what the themes are and where you think you might need to be starting to go to look for evidence. But I would like you to stay focused on your two significant things that you have chosen in your group, and you are looking for evidence to either support or contract those.	

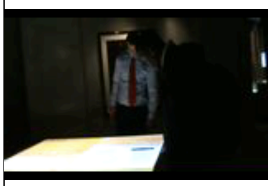
13	Sandra, Chelsea, and Dominic	Both students stop and turn towards Sandra.		Okay, so there is your map. You are also going to get a camera in your group, and if you find some things that you don't want to try and write down or draw particularly - that is, particularly strong, particularly visual evidence, it may be a document or an artefact - then you can take a picture of it on your camera and then bring it back in here, and if we really want to, we can print them out and you can have them to use in your feedback, okay. So there is a lot of stuff in there. There is text, there are artefacts, there are photographs, cartoons, and other bits and pieces as well. You are going to need to have a good look around the museum.	

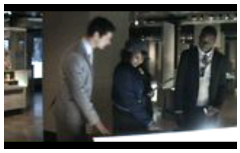
16.22	Sandra, Chelsea, and Dominic	Both students stop and turn toward Sandra.		And you need to make a record of it somehow, with your camera, writing it down, drawing it, whatever you think you are comfortable with, but you will need to make a record of your evidence because we are then going to come back in here and you are going to come back in here and you are going to need to talk about it in here and so you need to have it.So you are going to get, as I said, paper and pencil, camera, and a map. I am going to point you in the direction of the museum. Come with me straight away to the museum. I am going to be in there in about five or ten minutes. And if you need me for any reason, hopefully you won't, I will be at the end of the table. And so, in the museum, in the middle of the museum, there is a big lifeline, and you can see what you are going to get in there. It is a massive, great long table, interactive table, and at the end of it near there is a picture, a large picture, a portrait of Churchill in black and white. I will be there if anybody needs any help with cameras or any pencils, just to point you in the right direction. I think we will have about 15 minutes in there, and we will see how much we recorded somehow.	

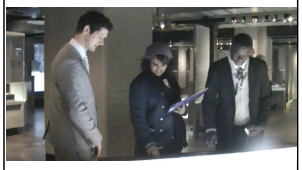
16.55	Chelsea and Dominic	All students enter the digital room. C and D begin to wander around. They both start reading some text on the opening panel. C spends more time on reading the textual panels. D starts looking at authentic exhibits in the cabinets. Both then walk toward a textual panel, when D pauses and turns toward C. C begins making more hand gestures when she talks. D starts walking toward the other glass cabinet and C follows him as she continues speaking to him.	D:What were your two words that you...? C: Confident and reliable. And the (.) most confidence, not reliability. Yeah, but I think that if you are confident and reliable as a leader. And it shows, like, other values, because we wrote a lot of things like strong-minded, opinionated, you have the confidence to be that. D: That might include other things. C: And the reliability sort of links some of those things as well. Yeah, so where do you think you might look to find one example of him being reliable, that is going to be (.) tricky. D: Probably in the war, maybe.		

17.46	Chelsea and Dominic	C looks down to her scarf, as the microphone is slipping. She then looks around the museum. D points at the other end of the museum. He then looks at C's camera. C points at the mini ceramic sculpture. D takes a closer look at it.	C: Yeah, yeah, maybe where he was quite good at that, because he says he is going to do something and then he does it. Right, because he worked through the coalition. Maybe we should take a picture of ourselves. My microphone thing keeps slipping. Where is everyone? D: They are outside. He always has a cigarette in his mouth. You should take a picture of that whole cigar thing. C: They made him a dog, oh. Did you know that the Churchill dog, was it named after him? D: It might be, you know, actually.		
18.4	Steve, Chelsea, and Dominic	C turns around to S, as he is not too far from where they are. S turns around and looks at the sculpture and smiles. C crosses her arms as S tries to explain about the Churchill dog association. D smiles as S explains. C steps aside and accidently triggers the other audio interactive devices.	C: Sir, you know the Churchill dog for the Churchill in that advert, was it named after him? S: Yeah, which is weird, because now when you Google 'Churchill', you get these insurance options, and it kind of taints the name a little bit. C: Uh-huh.		

19.17	Steve, Chelsea, and Dominic	S turns to the two students when asking the question. Later, he is called away by other students.	D: Well, this happens when you walk in front of it. C: I know, I was quite scared! S: So, what are your two features you're really looking for? C: Confident and reliable. D: Confident and... S: Oh, okay, confidence and reliability. So you have got Soviet and other things? This is hard. He builds confidence by doing a lot for his allies, for some of the countries that they were allies with before in the war. D: Hmm..		
21.33	Chelsea and Dominic	C quickly steps toward the picture and passes the camera to D. C then looks down at the Timeline table and begins to touch it. She then realises that it only functions if one uses the bar on the side of the table. D watches C playing with the bar but then begins to touch the other bar on the next part of the table.	C: Take a picture of me next to his picture, because it would look funny innit. Hold on. Wait, let's look for dates to see if he was reliable. Because if he said he was going to do something, in his like manifesto, to be the Prime Minister, then he should of have, erm, like (.) It's like a folder, isn't it? When was the date that he became like Prime Minister? D: It was like 1940, you know.		

22.36	Steve, Chelsea, and Dominic	C turns toward S again, as he is in the area. S looks down to the table and starts searching the 1940s area as he moves toward the end of the table. C starts touching the bar on the side of the table in order to open the digital file. A technical problem occurs as both C and D try to open the file. C keeps repeating her move. S stops touching the bar as he watches C trying to open the file.	C: Sir, do you know when Churchill became Prime Minister for the first time, because we are trying to look for his reliability in his, like, manifesto. S: Yeah, I think it's about 1940, I think, the war had just started and there is a Prime Minister, Neville Chamberlain, and so yeah, May 1940, Churchill becomes Prime Minister. How does this work? C: You touch that - ah, what is it doing? Yeah, it's on the wrong one. Okay, I am trying to, okay. What's it doing? It won't open. This is so confusing. Try it, try to go that way? We need you. It is not opening. My gosh, okay, we are trying to look for reliability resources. We can't find any. Oh. Okay, I think I managed to open. What have I done? S: Yeah, I think you just hold it on it and it will open.	The digital folder keeps closing quickly after they select it. The folder that C or D tries to open does not react to C's touch.	

23.5	Steve, Chelsea, and Dominic	C continues trying to open the 'month' file. D stops touching the table. S is called by another student, and so he then moves away from C and D.	C: Yay! Oh, my gosh. May. It went down there. S: It is down there. And if you got to match the events that happened... D: We are trying to look for this here. It keeps opening and not opening.		
24.09	Jason, Chelsea, and Dominic	J walks towards the two students as C looks more and more impatient and frustrated by the technical problem. Three people all look down at the table as J tries to open the file for them.	J: Which event are you looking for? C: May 1940, because we are trying to look for reliability in his manifesto when he became Prime minister. J: It is May 1940. C: Yeah, we are trying to open it. J: Okay, May 1940. You can probably get it down here. C: It is somewhere down there.		

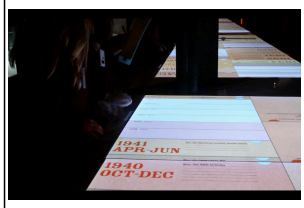
24.47	Jason, Chelsea, and Dominic	J looks at the two students' reactions and points at the file. He then moves to other area of the museum. C begins to read the file and open the other file. D tries to help C open another file. C points at the newly opened file. Both students read the textual resources.	J: Yeah, that is when they were in Italy. C: I can't use this. Let's see, Mussolini, you could say that it shows reliability because he was helping his country, really (.) You could say that it shows reliability because he was helping his country. D: Helped defend a country. C: Defend, yeah, defended country. When was that? September 1940. Should we move, because that thing is not helping, because it is not opening properly. It is doing it by itself now. Let's look for more. Oh, look. How do you, do you touch it or something? That is very cool. American relations with Roosevelt. I think that was when the Depression and everything was. Yeah. After, it was the aftermath of it, because I remember 1930, Roosevelt.		

29.44	Chelsea and Dominic	They move to the medal cabinet. D begins to look at the medals and points out to C what he is looking at.	C: Yeah. He had good international relations. Oh, when he was 70, he wanted to retire. Where is the flash for it? D: Those are all of his medals that he received. Wow. C: Yeah. I didn't think he was recognized as much as he should be. Take a picture of that. What is wrong with the (.) He had relations with Stalin. And it messed up now. I think we have got a lot. D: Is that when he died?		

Appendix F:
Multimodal Transcript for Group E

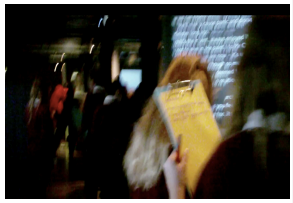
Multimodal Transcript for Group E
Group E Students: Hannah (H), Kate (K); Museum Educator Samantha (S)

Time	Participant	Facial Expression, Gesture & Body Movement	Language & Sound	Exhibit	Still Image of the Moment
3.05	Hannah and Kate	Hannah walks around the glass cabinet. Kate holds the clipboard and reads the labels after Hannah mentions the glass cabinet with a coat.	H: Is this the coat he wore? K: Worn by Churchill at the siege of Sydney – H: Is that the real coat? K: Oh, well they might do a replica of it. Well, he is responsible because he kept his coat clean.	Churchill's Coat	
3.58	Hannah and Kate	Hannah looks down to the label with Kate. She reads out the label slowly and starts writing information onto her clipboad. Hannah passes her clipboard to Kate.	H: He was in charge major events. So he was in charge of major events. People, so people had relied on him, yeah. K: Yeah. H: I can't spell. Oh, yeah, sorry, I forgot you are left handed.		
5.11	Hannah and Kate	Kate leans against a station to write down what Hannah suggests. Hannah starts pulling up the wooden boards from the wooden box one by one to read what is on each board.	H: Maybe some people didn't like agreeing with him. K: Some? H: Didn't agree. H: Like he was responsible even though like people didn't agree with him and stuff, didn't agree.	Wooden box with many small wooden boards, each with different leader's profile.	
6.22	Hannah and Kate	Hannah pulls out wooden panels from a wooden box, while Kate writes on her clipboard. Hannah then turns towards a textual panel while Kate tries to speed up writing.	H: Ah, I don't like him. H: Okay, that is gorgeous. Touch screen to start. H: So wow, he wrote a lot. He went, oh, no. He was from France, oh, he was in like in charge of giving out bad news and stuff and so. K: Uh-huh. Was he? H: Yeah, because if something bad happened, he would have to tell everyone. K: In charge of giving warnings. H: Yeah K: Wait, in charge of what? H: Like in charge of giving warnings.	same as above	
8.17	Hannah and Kate	They both began to walk around the textual panels and passed some glass cabinets. They stopped in front of the Timeline table.	H: Okay, right, like he had to work like ten times harder than anyone else, if you think about it. K: He was very important. H: Yeah, you can write than down basically. K: He was very important, what was the largest? H: I don't know, very important – Can't think of anything. K: Very important, oh wait, let's go over here, it's like a video.	Timeline Table	

10	Hannah and Kate	Hannah points at the projected table first and starts to scroll the bar on the side of the table. Meanwhile Kate sees what Hannah does and begins to browse the digital files.	H: Oh, my God, that is so cool. Wowoo, look at that. Oh, you click it. So June 1940. Okay, so Churchill again files or flies to France for crises, talks to French for – oh, he had to travel around. He had to travel quite a lot, and so. K: I don't even get it. Oh, I think that would be even better. H: Oh, wait, we could do about September. No, wait, maybe later, like a later kind of (.) I want to, like, December.	Timeline Table	
11.37	Hannah and Kate	Both of them scroll and browse the digital files simultaneously on the same side of the table. They both speak out loud about their actions on the table. Hannah finds a file relating to her mother's birthday. Kate tries to find a file that has her birthday on as she scrolls around the bar.	H: Oh, wait, here we go, that is my mom's birthday. Churchill writes Lieutenant Commander Brickford, Captain of the submarine HMS summer to launch he was to hear how Brickford torpedoed and seriously damaged two German cruisers early in the war, giving a major boost to public something, I don't know, I couldn't finish it. That is so cool. H: Oh October, here we go. K: What happened on my birthday? They don't have the 10th? Nothing must have happened on the 10th, okay. On this day –	Timeline Table	

13.51	Hannah and Kate	The reward effect happens as Hannah mentions. They both watch the short animation from the reward effect. Both of them continue reading their files. Hannah's digital file closes up quickly as she tries to find it again. Kate turns around and tries to help her.	H: Oh look, what did you do? H: So what happened on May 18th, so Churchill follows worsening news. He like gave bad news to not just England, but like other places, like France and stuff. K: Reliable for updating news. H: Yeah. K: Look at this! The effect is so cool. H: That is quite cool. I wonder what happened over here? K: It has video! H: Does it? Fabulous, Churchill was working in bed, to the first thing he did was – no, no, no, I'm not done yet.	Timeline Table	
14.28	Hannah and Kate	Kate points at the found file as Hannah reads out loud the file that she looses earlier.	K: No no, look at that one, is it this one? H: Okay. Churchill was first working in bed for the first Sea Lord Dudley, telephones him about sinking the Japanese aircraft carriers as well (.) many have died.	Timeline Table	

17.34	Hannah and Kate	Kate's digital file closes up as she tries to find it again. Hannah tries to write down what Kate says. Both of them lean against the table and try to write down some notes from the files.	K: Wait I was reading that. [as the file closes up] It was 1937, it was 1937, it was September. H: Oh, I just wrote that. K: You don't write, I am just reading it. [she just read out loud] H: Should we move on to over here. Look at how many there are. August 1950, this is right after the war. Churchill had repeatedly requested the Prime Minister – became Prime Minister. (writing notes as she speaks) Became, decided to be Prime Minister again. He must have quite liked being Prime Minister and liked the responsibility, because he decided to do it again after the war. K: Yeah.	Timeline Table	

18.22	Samantha, Hannah and Kate	Both of them turns towards Samantha when she shouts out about the time left.	S: Five minutes left, everybody, five minutes left. K: Oh no. H: Yeah. Liked having – yeah, wow. K: Check this out.	Timeline	
19.08	Hannah and Kate	Kate walks towards the medal cabinet as Hannah tries to follow her. Kate points at one of the medals. Hannah tries to look at it but then she finds another medal from the cabinet.	H: I did it again, no I didn't. Responsibility, K: Okay let's go over here. He must have been responsible. H: He must have been. Oh, look Belgium.	Timeline and Medal cabinet	

21.2	Hannah and Kate	Both of them read the label on the side of the cabinet and write down some notes on their clipboards.	K: What are all of these awards? H: Wow, he got a lot. K: This shows confident as well, look at all the crosses.	Medal cabinet	
22.46	Hannah and Kate	Kate turns to Hannah to express her opinion while Hannah continues writing.	K: Write it down as well. These are all like real important. H: He took care of his treasures. It is a quite honourable thing.	Medal cabinet	
23.46	Hannah and Kate	Kate and Hannah look at the exhibit while talking to each other. Hannah looks down and writes more notes on her clipboard. Kate looks towards Hannah and turns back towards her own clipboard. Hannah tries to write down what Kate says.	K: Don't write anything about sirens. H: Took care of his clothes. K: Hannah, there is something here, look. H: What? K: He made even more stuff after the war. H: Huh? He drove himself even harder. K: He worked very hard during the war. H: During the war.	Medal cabinet	

Appendix G:
Full Text for Group F Scenario

The four students were asked to be in a group for the museum activity. In common with the previous two groups, when in the learning centre activity, they opted for 'decisive' as the characteristic as a strong leader. They wanted to find out whether Churchill was decisive, and if he was a good leader. As they entered the digital room, they began by reading the first textual panel on Churchill's wartime career from 1940 to 1945, starting when he was elevated to the role of Prime Minister and concluding with the end of the war. Laura held a ruler that she took from the learning centre, then pointed at the panel and faced the others as they started forming a circle around the panel. 'Guys, guys,' she began, 'if you read it over here, it says that he became a symbol of what strong leadership should be when he nearly got defeated, but made it in doing so. And so that was basically saying that he was a strong leader, because he nearly, they nearly got defeated but they didn't.'

'This was in…' Ellie headed down and started to write some notes on her clipboard.

'This was the Second World War,' said Peter, finishing her sentence.

'Yeah, so?' Ellie continued as she looked up.

'So, we could say that he followed through, he probably followed through with decisions he made nearly, decisions he made to then become known as a strong leader,' Laura answered.

'And nearly got defeated, but…' David quickly replied.

'So just say he followed through with the decisions. Yeah, because he led them from near defeat to final victory, and they ended up, and then they ended up winning, and so he must have made decisions and followed through with it. So did you say it then goes from near defeat and then he managed to win?' Laura said to David

'Managed to win, okay.' Ellie wrote on her clipboard as she spoke.

'Should we walk on?' asked Laura, then smiled and led the way. The other three followed her for a while and started to look around in different directions and sections of the digital room.

David pointed out a photograph to Peter and Ellie while Laura was reading another textual panel on the opposite wall. 'All of them, he's got a cigar in his mouth. Apart from that and that.'

'I know, no, no, oh no, he's got one there,' Peter laughed.

Laura called for others' attention. 'Guys, here it says that some people liked him, so he was popular, but others disliked and distrusted him. And so maybe they thought he wasn't doing what was best for the country, and that was the reason for not getting…'

'Yeah,' said Ellie, turning around.

'And so that could be a reason for not voting,' Laura added as she looked at Peter and David.

'He was opposed a little bit,' Ellie said as she looked up.

'Yeah, so, like, he didn't, they didn't trust him to make the decisions,' Laura emphasised emphatically.

'Yeah,' Ellie nodded.

‘And so maybe that would be a reason why he wasn’t very decisive.’ Laura turned to Peter and David again as they both looked down at their clipboard to write notes.

The four of them moved down to another panel with some authentic exhibits of a Morse Code device and some digital screens showing how it was used at the time. The two girls read the text while the two boys turned to the other side to look at the uniforms that Churchill wore. Ellie turned to the boys and shouted, ‘That was very good, because he insisted on seeing how the war was fought.’

‘Yeah, he checked out new technology so that they could stay in the war,’ Laura added as she continued reading.

‘Yeah, so that was like, that was a good decision to make. Yeah, that was good, because he thought it was best to lay a bold attack instead of a defence. And so then, but then he didn’t, he wanted to avoid a mass slaughter, also, and so he didn’t want to kill those people. But, so he obviously made a good decision there, because then it led them to win the war,’ Ellie concluded as the boys walked toward them. She then suggested, ‘Should we walk down here, there’s that thing,’

Peter turned to David and said, ‘So, let’s look at the Lifeline, look at the Lifeline.’

Meanwhile, Ellie said to Laura, ‘Oh, there is Morse Code there.’

Peter stopped and turned toward Ellie, surprised. ‘I like Morse Code. Churchill had always understood that knowing what the enemy was planning was vital to winning the war. And so he was like…’

Laura cut him off, saying ‘He obviously made the decision when,’ as Ellie stated, ‘He, yeah, he had really strategies.’

David at the back mumbled quietly, ‘He did a lot of research.’

‘Yeah,’ Peter acknowledged.

‘Yes, see, because it helped him to get into the enemy’s mind, and he based many or all of his military decisions on it,’ Laura assured David.

‘Yeah,’ Ellie quickly agreed, as Laura added, ‘And so that’s how he was really, like, tactical.’

‘Very tactical,’ Ellie wrote as she echoed Laura.

Peter and David then went on to the glass cabinet where Churchill’s clothing was displayed. Peter laughed as he looked at the pyjamas that Churchill wore as he read out the label for the cabinet, ‘He was the only Prime Minister to wear military outfits. Hahaha…’

David laughed and exclaimed, ‘Hahaha, I am liking the pyjamas.’

Peter pointed and replied, ‘Look at his pyjamas. Oh, my God, it’s legendary!’

The two girls went on to the telescope device. Laura, at one telescope, asked Ellie, ‘What’s yours?’ as Ellie yelled, ‘Laura go in there, you can see the inside things, look inside it, you can see like, look!’

‘So, like, water blowing up. What’s yours?’ Ellie added as she continued looking into the device.

‘Basically,’ Laura slowly replied with hesitation.

‘With two men on the side,’ Ellie described.

‘It is a tank and it is firing. No, it is kind of showing something—one

side is showing it going under the sea, something like a field gun at the sea, and the other one is a tank. And yours looks like everything is blowing up and that there is like an animal running. No, that is just…' Laura explained as she looked up and turned to Ellie.

'Yeah, I know, you can go to different places. That is so cool. Now it's going over the sea and it's showing a tank on that left side,' Ellie replied, excited.

'Yeah, so I'm back in the tank now. This is so cool. Oh, it's just showing everything blowing up and then going into the sea, description, rocket propelled, high explosives. Purpose: designed to destroy enemy coastal defences. First used: project abandoned after test in 1944.' Laura stopped and started reading the textual panel next to the device, which labelled the purpose of the video.

'Which one are you on?' Ellie asked.

'I am on the, it is in the sea and it's got, there's nothing going through it. And the men are walking through the snow. And then now it's showing Churchill standing there with his men, and they've all got their things ready to fire, cannons or what,' Laura replied.

'And mine is like…' Ellie tried to describe.

'Listen to this. Defence factories. Description: rocket projectors. Oh, they are rocket projectors to destroy—purpose, to destroy enemy aircraft. First used in the United Kingdom in 1943, but unsuccessful. Okay, well, this was a bad idea. You could write this was a bad idea, because he used these things as defence factories, which fire rockets into the sky to kill, to destroy aircraft. But it said it was unsuccessful. And so you could say that he made a mistake with the military equipment.' Laura cut off Ellie's sightline as she pointed to the label.

'It's on the screen.' Ellie pointed at the other digital screen, which had the relevant information. She then wrote notes on the clipboard.

'And basically, no, it doesn't have it on the screen. I will show it to you, it is, okay, well they will come in a minute. These things, okay, factories, read it now.' Laura pointed at the screen as the text appeared.

'Unsuccessful,' Ellie read out, and wrote on her clipboard.

'Yes, so they were defence factories, which were designed to fire into the sky to destroy aircraft. And they were unsuccessful. They were to fire into the sky to destroy aircraft. Okay, where shall we go?' Laura walked forward to the other section of the museum as Ellie followed.

Later, they stopped at the Timeline table. Laura scrolled around the digital file and stopped. 'Wait, Churchill was very quick through his political roles. He didn't really fit into the political party. Within five years of arriving in Parliament, he became government minister. He made some enemies and changed his party twice.'

Ellie read it and replied, 'So he wasn't very decisive.'

'No, because he changed political parties twice,' Laura confirmed as she looked at Ellie's clipboard.

'So he wasn't decisive,' Ellie then read out loud slowly as she wrote on her clipboard.

Laura continued as Peter and David walked toward them, 'I think we

could take a picture of that, because it is showing how, you know, it is showing how he didn't stick to his guns, he didn't like—this shows how he changed his political parties twice, and so he had made a lot of enemies. And so he is kind of showing he wasn't decisive in his ideas, and kind of a bit of like a traitor, he's going from party to party.'

'Yeah.' Peter agreed.

'Do you have the camera?' Ellie asked Peter.

'No, someone has left one there.' He looked at a camera on a platform and approached it as he spoke.

'Also, we looked over there and we found that he joined the army very young. Then he cut it all to be a politician.' David pointed his right hand at the other museum exhibits.

The two girls exclaimed, 'Yeah?' and Laura queried, 'Did he?'

David further explained, 'And so it is kind of saying that if he wasn't doing then, he would be that.'

Laura then said, 'He didn't follow through in his decisions. Yeah, so, should we get the camera and take a picture of that?'

Ellie replied, 'Yeah and then we need to find it as well.'

'He chose to give up his position as assigned for the front lines in France in 1915,' Peter read from one of the nearby textual panels to get the others' attention.

'No, he's made some really good decisions, but then he's also, like, just hasn't stuck to his guns on some things, so he just moved from two different parties,' Laura argued.

'Yeah,' Ellie quickly agreed.

'Look, Ellie, here, it says there were military and political indecisions and the compromise model meant that thousands of Allied troops were to die in a hopeless situation. So because he was indecisive and so it led a lot of people to die,' Laura read on another digital screen.

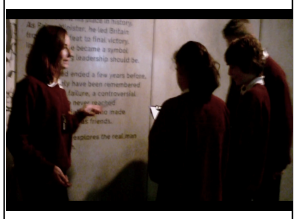
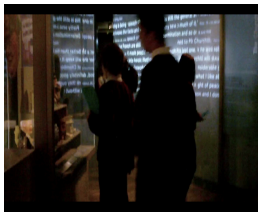
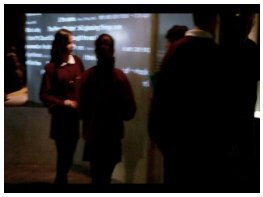
'Yeah. Resulted in many people dying,' Ellie repeated as she read along.

'And this is what Peter was saying. Yeah, because he was, he became a soldier and then he just kind of gave up it all up to become a politician. And so he just gave it all up to become a politician, and so he didn't, he wasn't strong with his decision deciding what he wanted to be. He didn't pursue that career, he just changed it. The board over there.' Laura pointed at the screen for Ellie while looking at Peter's facial expression. She then continued, 'Well, take a picture of that one, because that would show, like, this is the one where it shows that he was indecisive, because he made the wrong decisions in the military threat and it led them to lose a lot of lives. Yeah, sorry. Should we just take one?'

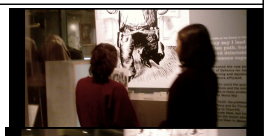
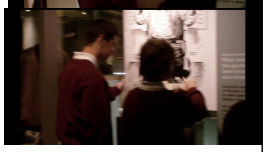
Ellie took the camera off David as Laura pointed at the cartoon image on the textual panel.

Appendix H:
Multimodal Transcript for Group F

Multimodal Transcript for Group F
Group F Students: Peter (P), David (D), Ellie (E), and Laura (L)

Time	Participant	Facial Expression, Gesture & Body Movement	Language & Sound	Exhibit Encountered by Students	Still Image of the Moment
23:25	Peter, David, Ellie, and Laura	All begin to read the textual panel. L holds a ruler pointing at the screen while two of them take notes and one of them reads the wall text as she summarises it.	L: Guys, guys, if you read it over here, it says that he became a symbol of what strong leadership should be when he nearly got defeated, but made it in, in doing so. And so that was basically saying that he was a strong leader, because he nearly, they nearly got defeated but they didn't. E: This was in – P: This was the Second World War. E: Yeah, so – L: So, we could say that he followed through, he probably followed through with decisions he made nearly, decisions he made to then become known as a strong leader.	Textual Panel on Churchill's 1940-1945 wartime career. It contains one illustration and four paragraphs of textual information.	
24.01	Peter, David, Ellie, and Laura	D, E, and P are looking at the exhibited object while L reads the other textual panel.	D: And nearly got defeated, but – L: So just say he followed through with the decisions. Yeah, because he led them from near defeat to final victory, and they ended up, and then they ended up winning, and so he must have made decisions and followed through with it. So did you say it then goes from near defeat and then he managed to win. E: Managed to win, okay. L: Should we walk on? D: All of them, he's got a cigar in his mouth. Apart from that and that. P: I know, no, no, oh no, he's got one there.	D, E, and P are looking at the glass cabinet that contains a series of ceramic models and sculptures of Churchill. L is reading a projected text on another panel of quotations on how people perceive Churchill's war role.	
25.11	Peter, David, Ellie, and Laura	L asks the others to read the digital text, and while they are reading it, she tries to summarise the content of the text. E spends most of the time writing down what L is explaining. P begins to look around the other part of the museum.	L: Guys, here it says that some people liked him, so he was popular, but others disliked and distrusted him. And so maybe they thought he wasn't doing what was best for the country, and that was the reason for not getting... E: Yeah. L: And so that could be a reason for not voting. E: He was opposed a little bit. L: Yeah, so like he didn't, they didn't trust him to make the decisions. E: Yeah. L: And so maybe that would be a reason why he wasn't very decisive. E: People didn't trust him. L: And then do you have to read it?	Digitally projected textual panel	

27.5	Peter, David, Ellie, and Laura	P and D begin to look at the other cabinet where Churchill's uniform is stored. E and L carry on reading the textual panel. L begins to lead the group again by trying to get the whole group's attention. P and E still try to write down as much as they can on their worksheet.	E: That was very good, because he insisted on seeing how the war was fought. L: Yeah, he checked out new technology so that they could stay in the war. E: Yeah, so that was like, that was a good decision to make. Yeah, that was good, because he thought it was best to lay a bold attack instead of a defence. And so then, but then he didn't, he wanted to mass slaughter, also, and so he didn't want to kill those people. But, so he obviously made a good decision there, because then it led them to win the war. Should we walk down...here, there's that thing.	P and D look at the glass cabinet where Churchill's uniform is stored. E and L read another digital screen, which has other text about Churchill's wartime statement and famous quotations.	
28.33	Peter, David, Ellie, and Laura	The group slowly begins to split into two groups: E and L, and P and D. P and D move toward the Lifeline device while E and L go toward another cabinet that has a Morse Code device. Before the group fully breaks into two groups, they congregate one more time to discuss and write some notes on their clipboards.	P: So, let's look at the Lifeline, look at the Lifeline. E: Oh, there is Morse Code there. P: I like Morse Code. Churchill had always understood that knowing what the enemy was planning was vital to winning the war. And so he was like – L: He obviously made the decision when... E He, yeah, he had real strategies.	P and D move toward Lifeline table. E and L look at the Morse Code device.	

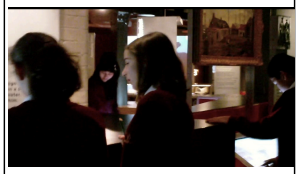
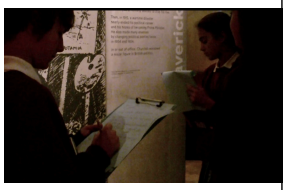
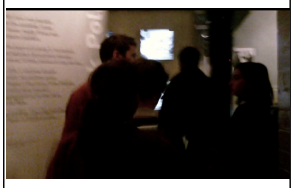
30.46	Peter, David, Ellie, and Laura	As above.	D: He did a lot of research. E: Yeah. L: Yes, see, because it helped him to get into the enemy's mind, and he based many or all of his military decisions on it. E: Yeah. L: And so that's how he was really, like, tactical. E: Very tactical [writes down the notes].	As above.	
31.22	Peter, David, Ellie, and Laura	The group is separated into two. P and D stop writing on clipboards and start browsing different cabinets. L and E continue reading different textual panels briefly. L talks most of the time to E as E writes the notes.	P: He was the only Prime Minister to wear military outfits. Hahaha... D: Hahaha..I am liking the pyjamas. P: Look at his pyjamas. Oh, my God, it's legendary! Working for Churchill was... L: He would usually light the first cigar shortly after breakfast. He smoked about eight a day, constantly relighting them and never inhaling. E: He smoked a lot.	P and D browse glass cabinets of Churchill's clothing and some authentic objects. L and E spend most of the time reading textual panel.	 

32.33	Ellie and Laura	The two groups reunite coincidentally in front of the glass cabinet that contains Churchill's medals. D spends more time pointing at the different medals. L begins reading the label of the cabinet.	L: Oh, my God, Ellie, look at all of his medals. E: Oh, my God. L: He has a lot of medals. E: And these are like the actual ones? L: These are the actual ones. Yeah. E: That is cool. L: Order of Ministry Merit, First Class, and so he always, he led the military very well. E: Yeah. L: He's got literally, got from all different countries. E: I know. L: He would always attend worldwide events. E: British War Medal.	They all arrive at the glass cabinet containing all Churchill's medals.	

35.49	Ellie and Laura	L and E quickly browse a couple of glass cabinets and move toward the Lifeline table	L: See, like, he declined the offer to be a Duke. E Yeah. L: And so he obviously didn't want that kind of status, he just wanted to be known as who he was. Did you know that? That is so cool. E: Oh, I did. L: Okay, so where should we go? Where should we start from?	Lifeline Table	

36.53	Ellie and Laura	The two groups face each other and begin to scroll the bar on the side of the Timeline table. All of the students stop writing information down and just browse the table.	E: Why are you coming all the way down here? It is 1943 and the war was over, I think. This was the second best one. Churchill's son, Randolph, writes to him what has happened, we clearly have a great victory. And someone remarked, 'We didn't pull out of the war. Churchill's talked them out.' See, that was why he obviously used good methods, because he didn't feel like he wanted to bomb them and do a mass slaughter, he just talked them out of it. E: Yes. L: And I think that is the message. And because that is, like, the message of a true leader, that they can actually, it doesn't have to result in war, it can actually just result in just talking. E: Yeah. L: I think it's fine.	Timeline Table.	 

40.32	Ellie and Laura	L and E move toward the telescope devices and start looking into them. L reads some of the textual information on the label next to one device.	E: Laura, go in there, you can see the inside things, look inside it, you can see, like, look. L: What's yours? E: So, like, water blowing up. What's yours? L: Basically – E: With two men on the side. L: It is a tank and it is firing. E: Yeah. L: No, it is kind of showing something – one side is showing it going under the sea, something like a field gun at the sea, and the other one is a tank. And yours looks like everything is blowing up and that there is like an animal running. No, that is just –	Telescope devices	
41.06	Ellie and Laura	Same as above	L: Yeah, I know, you can go to different places. That is so cool. Now it's going over the sea and it's showing a tank on that left side. E: Yeah, so I'm back in the tank now. L: Yeah. This is so cool. Oh, it's just showing everything blowing up and then going into the sea, description, rocket propelled (.) high explosives. Purpose: designed to destroy enemy coastal defences. First used: project abandoned after test in 1944. E: Which one are you on?	Telescope devices	
44.55	Ellie and Laura	L and E move toward the telescope devices and start looking into them. L reads some of the textual information on the label next to one device. They begin to go and find the other two (D and P) as they move toward the Lifeline table again. After they realise that D and P are not in that area, they begin moving toward another screen that has information about the defence factories.	L: I am on the, it is in the sea and it's got, there's nothing going through it. And the men walking through the snow. And then now it's showing Churchill standing there with his men, and they've all got their things ready to fire, cannons or what – E: And mine is like (.) L: Listen to this. Defence factories. Description: rocket projectors. Oh, they are rocket projectors to destroy – purpose, to destroy enemy aircraft. First used in the United Kingdom in 1943, but unsuccessful. Okay, well, this was a bad idea. You could write this was a bad idea, because he used these things as defence factories which fire rockets into the sky to kill, to destroy aircraft. But it said it was unsuccessful. And so you could say that he made a mistake with the military equipment. E: It's on the screen.	L and E use the telescope devices. They go back to the Lifeline table for a few minutes after the telescope devices. They then move toward another platform that contains some touch information about the defence factories.	

45.24	Ellie and Laura	L starts reading more of the text and points it out to E. Both of them try to watch the video, but L starts looking around to find P and D.	L: And basically, no, it doesn't have it on the screen. I will show it to you, it is, okay, well, they will come in a minute. These things, okay (.) factories, read it now. E: Unsuccessful. L: Yes, so they were defence factories which were designed to fire into the sky to destroy aircraft. And they were unsuccessful. They were to fire into the sky to destroy aircraft. Okay, where shall we go?	L and E are on the screen that has photographs, video, and textual information about the defence factories.	
47.33	Ellie, Peter, and Laura	L and E move toward another textual board and start reading the text out loud. P and D decide to join; D starts writing notes down when L is expressing her opinion.	L: Wait, Churchill was very quick through his political roles (.) he didn't really fit into the political party. Within five years of arriving in Parliament, he became government minister (.) He made some enemies and changed his party twice. E: So he wasn't very decisive. L: No, because he changed political parties twice. E: So he wasn't decisive. L: I think we could take a picture of that, because it is showing how, you know, it is showing how he didn't stick to his guns, he didn't like – this shows how he changed his political parties twice, and so he had made a lot of enemies. And so he is kind of showing he wasn't decisive in his ideas, and kind of a bit of like a traitor, he's going from party to party. P: Yeah.	L and E move toward another textual panel regarding how Churchill was defeated in the 1945 election. P and D join the conversation at the same location.	
47.57	Peter, David, Ellie, and Laura	E turns to P to ask about the camera and P walks toward it. D joins the conversation as he writes information down on his clipboard. P hands the camera over to E and reads out the textual information he finds that is relevant to the discussion.	E: Do you have the camera? P: No, someone has left one there. D: Also, we went over there and we found that he joined the army very young. Then he cut it all to be a politician. L and E: Yeah? L: Did he? D: And so it is kind of saying that if he wasn't doing this then he would be that. L: He didn't follow through in his decisions. Yeah, so, should we get the camera and take a picture of that? E: Yeah. L: And then we need to find it as well. P: He chose to give up his position as assigned for the front lines in France in 1915.	All of them are standing in the area where the textual panels display information about Churchill's career during 1900-1929. It was the time when Churchill served in the sinecure of Chancellor of the Duchy of Lancaster.	

48.3	Peter, David, Ellie, and Laura	L faces the other three.	L: No, he's made some really good decisions, but then he also, like, just hasn't stuck to his guns on some things, so he just moved from two different parties. E: Yeah. L: Look, Emily, here it says there were military and political indecisions and the compromised model meant that thousands of Allied troops were to die in a hopeless (.) so because he was indecisive and so it lead a lot of people to die.	As above.	

50.02	Ellie and Laura	L talks to the rest of the group and points at the other end of the museum. The other three stand in the same place and E quickly takes the picture that L suggests.	E: Yeah (.) resulted in many people dying. L: And this is what Peter was saying. Yeah, because he was, he became a soldier and then he just kind of gave up it all to become a politician. And so he just gave it all up to become a politician, and so he didn't, he wasn't strong with his decision deciding what he wanted to be. He didn't pursue that career, he just changed (.) The board over there. We've got to get, well, take a picture of that one, because that would show, like, this is the one where it shows that he was indecisive, because he made the wrong decisions in the military threat and it led them to lose a lot of lives. Yeah, sorry. Should we just take one?	They moved back to the place where they started (1940-1945).	

Appendix I:
CUREC Letter of Approval

SOCIAL SCIENCES & HUMANITIES
INTER-DIVISIONAL RESEARCH ETHICS COMMITTEE

Hayes House, 75 George Street, Oxford. OX1 2BQ
Tel: +44(0)1865 614871 Fax: +44(0)1865 614855
ethics@socsci.ox.ac.uk www.socsci.ox.ac.uk

Co-ordinator of the IDREC
Social Sciences Divisional Office

UNIVERSITY OF OXFORD

Ref. SSD/2/3/IDREC

October 22, 2010

Ms Ariel Liu,
Department of Education,
15 Norham Gardens

Dear Ms Ariel Liu,

Application Approval

Ref No.: SSD/CUREC1/10-414

Title: Technology-Enhanced Learning in Museums: Using multimodal analysis to explore visitors' learning experience

The above application has been considered on behalf of the Social Sciences and Humanities Inter-divisional Research Ethics Committee (IDREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to the IDREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly approval has been granted.

Should there be any subsequent changes to the project, which raise ethical issues not covered in the original application, you should submit details to the IDREC for consideration.

Yours sincerely,



Dr Chris. Ballinger

Cc. Dr Chris Davies, Department of Education, 15 Norham Gardens
Matt Cothier, Department of Education, 15 Norham Gardens

Appendix J:
Information leaflets for both museums

Further Information and questions

If you have any questions, please do not hesitate to contact me. Contact information is on the next page.



We understand that you have the right to withdraw from this study at any time, should you wish, and that your child has the right to decide not to take part.

The project has been reviewed by and received ethics clearance from the University of Oxford Research Ethics Committee. The study is carried out in accordance with the Freedom of Information Act.

If you would like to know more about the study, please contact:

Ariel Liu, Research Student
Ariel.liu@education.ox.ac.uk

Dr. Chris Davies, Research Supervisor
Chris.davies@education.ox.ac.uk

Address
Department Of Education
University of Oxford
15 Norham Gardens
Oxford
OX2 6PY

UNIVERSITY OF OXFORD

How does technology improve the learning experience in museums?

Information for Participants

In association with

Natural History Museum, London
Churchill Museum, London

NATURAL HISTORY MUSEUM

IMPERIAL WAR MUSEUM

What is this project about?

The study looks at how technology can improve visitors' learning experience in museums.



We want to learn how to help visitors, especially young adults and children, get the most out of using these facilities for educational purposes.

Technology and young people

As technology develops, many museums add new digital installations to their displays for learning support.

Many of these have multiple forms of interaction, from computer simulations to hands-on touch screens. But how supportive and effective are they for students? It is very important to get a clear picture of how technology helps, or whether it helps at all.



We are keen to find out how young people interact with these devices and whether they find them useful.

How do I get involved?

With your permission, we will talk to you after your visit at the museum about your experiences with technological installations and activities.

You will be invited to participate in a twenty-minute interview. This will be an informal conversation, which we hope you will find interesting.

You will have a chance to tell us about your learning experience and about things that you think would help you better understand the museum exhibits. The results will be used to help improve how technology is used for museum learning. There will also be a follow-up interview three months after the first interview.

Further Information and questions

If you have any questions, please do not hesitate to contact me. Contact information is on the next page.



You have the right to withdraw from this study at any time, should you wish, and that your child has the right to decide not to take part.

The project has been reviewed by and received ethics clearance from the University of Oxford Research Ethics Committee. The study is carried out in accordance with the Freedom of Information Act.

If you would like to know more about the study, please contact:

Ariel Liu, Research Student
Ariel.liu@education.ox.ac.uk

Dr. Chris Davies, Research Supervisor
Chris.davies@education.ox.ac.uk

Address
Department Of Education
University of Oxford
15 Norham Gardens
Oxford
OX2 6PY

UNIVERSITY OF OXFORD

How does technology improve the learning experience in museums?

Information for Schoolteachers and Museum Educators

In association with

Natural History Museum, London & Churchill Museum, London

NATURAL HISTORY MUSEUM

IMPERIAL WAR MUSEUM

What is this project about?

The study looks at how technology can improve visitors' learning experience in museums.



We want to learn how to help visitors, especially young adults and children, get the most out of using these facilities for educational purposes.

Technology and young people

As technology develops, many museums add new digital installations to their displays for learning support, from computer simulations to hands-on touch screens.

But how supportive and effective are they for students? It is very important to get a clear picture of how technology helps, or whether it helps at all.



We are keen to find out how young people interact with these devices and whether they find them useful.

How do I get involved?

With your permission, we will talk to you or your child at the museum or at school after your/his/her visit. We will discuss your/his/her experiences with technological installations and activities.

You will be invited to participate in an twenty-minute interview. This will be an informal conversation, which we hope you will find interesting.

You will have a chance to tell us about your/their learning experience and about things you think would help you/they better understand the museum exhibits. There will also be a follow-up interview three months after the first interview.

Further Information and questions

If you have any questions, please do not hesitate to contact me. Contact information is on the next page.



You have the right to withdraw your child from this study at any time, should you wish, and that your child has the right to decide not to take part.

The project has been reviewed by and received ethics clearance from the University of Oxford Research Ethics Committee. The study is carried out in accordance with the Freedom of Information Act.

If you would like to know more about the study, please contact:

Ariel Liu, Research Student
Ariel.liu@education.ox.ac.uk

Dr. Chris Davies, Research Supervisor
Chris.davies@education.ox.ac.uk

Address
Department Of Education
University of Oxford
15 Norham Gardens
Oxford
OX2 6PY

How does technology improve the learning experience in museums?

Information for Parents/Guardians

In association with

Natural History Museum, London and Churchill Museum, London

What is this project about?

The study looks at how technology can improve visitors' learning experience in museums.



We want to learn how to help visitors, especially young adults and children, get the most out of using these facilities for educational purposes.

Technology and young people

As technology develops, many museums add digital installations to their displays for learning support, from computer simulations to hands-on touch screens.

But how supportive and effective are they for students? It is very important to get a clear picture of how technology helps, or whether it helps at all.



We are keen to find out how young people interact with these devices and whether they find them useful.

How do I get involved?

With your permission, we will film and talk to your child at the museum and at school after his/her visit. We will discuss his/her experiences with technological installations and activities.

Your child will be chosen randomly and will be filmed during the activity in the museum. He/She will also be invited to take part in a short interview. This will be an informal, twenty-minute conversation, which we hope your child will find interesting.

He/she will have a chance to tell us about his/her learning experience and about things that he/she thinks would help him/her better understand the museum exhibits. There will also be a follow-up interview three months after the first interview.

The filming material will only be used for this particular research; everything will be remained anonymous and will be destroyed after the research.

Appendix K:

Consent forms

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens
Oxford, OX2 6PY
Tel: +44 (0) 1865274024
Email: ariel.liu@education.ox.ac.uk

Technology-Enhanced Learning in Museums: Using multimodal analysis to explore visitors' learning experience.

This research aims to explore how museum visitor interact, experience and learn from museum activities and technologies. It is undertaken by Ariel Liu, a DPhil student at the Department of Education, University of Oxford.

Please read the text and then complete the box below.

- I have read and understood the information about this study and have had the opportunity to ask questions and get satisfactory answers about this study.
- I understand that I can withdraw from the study without any consequences at anytime simply by informing the researcher of my decision.
- I understand who will have access to identifying information provided and what will happen to the data at the end of this project.
- I understand that the process will be audio recorded.
- I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee I agree to participate in this study".

NAME	
DATE	
SIGNATURE	

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens
Oxford, OX2 6PY
Tel: +44 (0) 1865274024
Email: ariel.liu@education.ox.ac.uk

Technology-Enhanced Learning in Museums: Using multimodal analysis to explore visitors' learning experience.

Dear Parents/guardians,

Thank you for your time, I am asking permission to include your child in the above research. The attached leaflet has an exact breakdown of what will happen during the study and how the gather information will be used.

The project will be fully supervised at all time by a member of staff and will not interrupt your child's learning. All follow up work after the museum visit will be done during one lesson a week and three month after the visit, again fully supervised. Audio and video recordings of conversations will be made for research purpose. Thank you very much for your consideration and help!

Parent/guardian consent form

Please tick as appropriate

- ❑ I have read the information outlined in the leaflet
- ❑ I agree to my child's participation in this study
- ❑ I understand I can opt-out from this research at any time

Child's name (block capitals)…….. ……

Parent/guardian name (block capitals) ……

Parent/Guardian signature: ……Date: ……

Best Wishes,

Ariel Liu