

THE *DISTOMUSINQ* FRAMEWORK: DIGITAL STORYTELLING FOR  
STUDENTS' INQUIRY-BASED MUSEUM LEARNING

Thesis submitted for the degree of  
Doctor of Philosophy  
at the University of Leicester

By

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## Copyright Declaration

'I, Zoi Tsiviltidou, declare that the PhD thesis entitled 'The *DiStoMusInq* framework: Digital storytelling for students' inquiry-based museum learning' is no more than 80,000 words in length including quotes and exclusive of the abstract, acknowledgements, appendices, contents, figures, footnotes, tables, the list of publications and the references. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other degree. Except where otherwise indicated, this thesis is my own work.'



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Signature

21 March 2019

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Date

## List of publications

- Tsiviltidou, Z., 2015. Digital storytelling in museum education. Proceedings of *SINS Summer School in Narrative Studies 2015*. Aarhus: Aarhus University.
- Tsiviltidou, Z., 2015. Digital storytelling with mobile media for inquiry-based museum learning: The student as author of the museum experience. Proceedings of *IEEE Computer Society International Conference on Interactive Mobile Communication Technologies and Learning 2015*. Thessaloniki. pp. 91-95.
- Tsiviltidou, Z., 2016. Digital storytelling in the museum: The student as author of the inquiry-based learning experience. *From Narrative to Narrativity Journal*. 1(1), pp. 205-215.
- Tsiviltidou, Z., and Vavoula, G., 2017. Digital storytelling as a framework for inquiry-based museum learning. Proceedings of *IEEE Computer Society International Conference on Advanced Learning Technologies 2017*. Timisoara. pp. 403-405.
- Tsiviltidou, Z., and Vavoula, G., 2018. Digital stories for web-based museum investigations for inquiry-based learning. Proceedings of *IEEE Computer Society International Conference on Interactive Mobile Communication Technologies and Learning 2018*. Ontario. pp. 230-238.
- Tsiviltidou, Z., and Vavoula, G., (submitted). Digital storytelling for inquiry-based learning on school museum trips: Engagement and research skills confidence. *Journal of Research on Technology in Education*.
- Tsiviltidou, Z., and Vavoula, G., (submitted). Digital stories with the online collection of the Victoria and Albert museum for inquiry-based learning. *Journal on Computing and Cultural Heritage*.

# The *DiStoMusInq* framework: Digital storytelling for students' inquiry-based museum learning

By Zoi Tsiviltidou

## Abstract

Digital storytelling gains momentum in museum practice, being increasingly applied to enrich the programs for schools. In this thesis I probe into how the digital storytelling process could frame students' explorations of museum content in the context of inquiry-based school museum trips. The *DiStoMusInq* framework was developed to articulate the three-staged mapping between the inquiry-based learning process and the process of crafting a digital story. The methodology was exploratory, having a series of three trials designed with pre-visit, on-visit and post-visit activities that involved 70 middle school and high school students of an international school in Thessaloniki, Greece. The objective was to examine three different ways in which digital stories could be the objective and outcome of student group museum inquiries. Students conducted museum investigations structured around personally set questions using their own smartphones, tablets and laptops, and produced a digital story to present their findings. The research revealed that there is a synergy between the two processes, and increased self-reported confidence in student research skills, but the interplay is not linear; it is dialectic, with each stage feeding into the others and with inquiry and digital storytelling driving each other. The findings fed into a refined version of the *DiStoMusInq* framework and the identification of benefits of its integration with school museum trip planning. This study furthers our understanding of inquiry-based museum learning embedded in school curricula because it shows us how and why to use digital stories as outputs of self-initiated and self-directed inquiries. The thesis concludes with proposing directions for further research to broaden the scope of this inquiry beyond school trips towards web-based museum visits. The research reported here thus paves the way for newly envisioned applications of digital stories in the twenty-first century museum.

**Key words:** museums, school visits, digital stories, inquiry-based learning, mobile devices



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- Footnote 1: The word *storytelling* (1709) comes from the Old French and English language of the 1200s-1300s and is a compound word of the noun *story* and the verb to *tell*, meaning an account of something, a narrative of past or fictitious events; the former is from *historia*<*estorie*, meaning the relation of incidents, a chronicle, and it relates to the verb to *see* (past tense ὥθει of the Greek verb οἶδα, which means to *know*); and the latter is from the Old English *tellan*<*talo*, later also *tale*, meaning to account, mention in order, narrate, relate, announce (Babinotis, 2011).
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## Chapter One

### INTRODUCTION

‘Honest authors realise that their books are never as good as they had planned them.’

-Ransome, 1909: n.p.

One hundred and ten years ago Ransome (1909) warned us in all honesty against the self-indulging pride of finishing a book. In an inimitably succinct fashion, he reminded us that a book is a work in progress that we mistakenly think is finished. I wrote this thesis as clearly, rigorously and thoroughly as possible without compromising fun, keeping in mind that revelations will come to light after the submission date.

#### 1.1 Thesis overview

In this thesis I probe into how the digital storytelling process can frame students’ explorations of museum content in the context of inquiry-based school museum trips. I developed the *DiStoMusInq* framework to articulate the three-staged mapping between the inquiry-based learning process and the process of crafting a digital story. I tested it in a series of three trials with pre-visit, on-visit and post-visit activities that involved 70 middle school and high school students of an international school, aged 10-17 years old. I explored three different ways in which digital stories can be the objective and outcome of student group museum inquiries. Students conducted museum investigations structured around personally set questions using their own smartphones, tablets and laptops, and produced a digital story to present their findings. The research revealed that there are synergies between the two processes, but the interplay is not linear. It is dialectic, with each stage feeding into the others and with inquiry and digital storytelling driving each other. The findings fed into a refined version of the *DiStoMusInq* framework and the identification of benefits of its integration with school museum trip planning. This study furthers our understanding of inquiry-based museum learning embedded in school curricula because it shows us how and why to use digital

stories as outputs of self-initiated and self-directed student group museum inquiries. The thesis concludes with proposing directions for further research to broaden the scope of this study beyond school trips to web-based museum visits. The research thus paves the way for newly envisioned applications of digital storytelling in the twenty-first century museum.

## **1.2 Scope and context**

### **1.2.1 Inquiry-based museum learning in Greek private schools**

The scope of this research is constructivism-based learning with a focus on inquiry-based museum learning in Greece and more specifically in private schools. The curricula of both public and private schools in Greece include organised school visits to museums in order to promote an appreciation of culture and history and extend the in-class work. These field trips are planned under the aegis of the Department of Educational Programs of the Ministry of Culture and Sports and they are based on exams preparation content with specific objectives and outcome-oriented activities for the students. That is because teaching in public and most private schools -except of international and experimental schools- is guided by content-specific knowledge with exam-oriented goals and little room for inquiry. This means that self-initiated and self-directed discoveries do not fit the organised school museum visit. Also, public schools do not allow the use of personal mobile devices in the classroom. As such they are distinct from private schools because of what is taught and learned, how and the means by which it is assessed.

At the same time, museums in Greece become more and more visitor-centric (Dalkos, 2000; Economou, 1999; Kakourou-Chroni, 2006; Nikonanou and Kasvikis, 2008; Tziaferi, 2005), offering less structured learning for all visitors including students who visit in groups. Learning programs are designed more as a complement to classroom work and less to replace it (Nikonanou, 2010; Vemi and Nakou, 2010). The content of the activities is aligned with the demands of the exam-oriented curricula, but the ways information is delivered are more open to the students' interpretations and less focused on the outcomes. Also, more and more museums in Greece embrace digital

technologies to enliven the visiting experience and support self-directed learning. With personalised navigation (c.f. Bounia et al., 2010; Hawkey, 2004; 2006; Nikonanou et al., 2015; Pujol and Economou, 2006) students are allowed explorations driven by a spirit of inquiry. This enables them to discover new concepts for themselves (Wurdinger and Carlson, 2010), interacting with the objects and others.

These specific aspects of the Greek context for school and museum learning make this study urgent and useful. It is urgent because the integration of inquiry-based learning and digital technologies for engagement is gaining ground in educational settings in Greece. And it is useful because it aims to explore how students' digital stories support self-initiated and self-directed museum inquiries with a positive impact on their research skills development. By doing so, it contributes a framework for building a flexible relationship between museums and schools where learning outcomes are not dependent on exam-preparation outcomes but rather on personal meaning-making in the form of a digital story.

### **1.2.2 Learning in the twenty-first century museum**

In the 1980s and early 1990s constructivism developed into an instructional approach (Brooks and Brooks, 1993; Duffy and Cunningham, 1996; Fosnot, 1996; Jonassen, 1991; 1999; Jonassen et al., 1999; Karagiorgi and Symeou, 2005; Phillips, 1995; Prince and Felder, 2007; Steffe and Gale, 1995; Wilson, 1996; von Glaserfeld, 1995). Constructivism was based on Dewey's (1938) *learning by doing* and explained how people construct their own meaning by building on prior knowledge and experiences (Piaget, 1972). Socio-cultural constructivism added that meaning making is as much influenced by the environment as by interactions with others (Vygotsky, 1978). Drawing on constructivism, approaches for learning outside the classroom (c.f. Resnick, 1987) grew in popularity. Studies showed that field trips consolidate and extend classroom-based knowledge as students demonstrate cognitive gains (Stronck, 1983), skills development (Greene et al., 2014) and information retention over time (Falk and Balling, 1982). Museum school trips were 'a valuable supplement and addition' to classroom work (DeWitt and Storksdieck,

2008: 182); a way to introduce students to museum collections and engage them in cultural heritage interpretation and appreciation.

At the same time, museums started to redefine their social role, responding attentively to their visitors' expectations and needs (Falk, 2016). And in the early twenty-first century, many museums became visitor-centric, expanding into inclusive places of technology-enhanced interaction, which enriches engagement and experience-driven personalised learning (Ciolfi et al., 2001; Kotler and Kotler, 2004), and thus blurs interaction boundaries for the visitor (Galani and Chalmers, 2008). As such, museums have extended the experience from passive observation and knowledge accumulation to multi-sensory and thought-provoking engagement (Ardito et al., 2009; Arvanitis, 2005; Bearman and Geber, 2008; Kidd, 2014; Roussou, 2001).

In the museum, constructivism has been implemented into learning programs across ages and contexts (Ansbacher, 1998; Ansbacher, 1999; Chang, 2006; D'Acquisto, 2006; Falk and Dierking, 1992; Falk and Dierking, 2000; Falk and Storksdieck, 2005; Hein, 1998a; Hein, 1998b; Hein, 2004; Hooper-Greenhill, 1999; Hooper-Greenhill, 2007; Jeffery-Clay, 1998; Kolb, 1984; Kolb et al., 2001; Perry, 1992; Silverman, 1995). Hein (1998a) claimed that hands-on and minds-on interactions with objects construe for learning because students are given ways 'to reach conclusions, experiment, and increase their understandings' (1998a: 34). Hooper-Greenhill (1999) added that '[i]nterpretation is the process of *constructing* meaning' (1999: 12, italics in original). Similarly, Jeffery-Clay (1998) claimed that museums are environments for knowledge construction because museums offer students 'first-hand experiences with objects that can involve looking, handling, interacting, or actually experimenting' (1998: 3). And Caulton (1998) agreed that students 'draw their conclusions about the meaning of the exhibition' when they construct their own knowledge (1998: 35-36). Nowadays, more and more museums encourage visitors, including students, to become content producers (Simon, 2010) to interpret the collections in their own terms. That is why they are prompted 'to participate and become intellectually involved, touching objects, posing questions, manipulating machines, smelling an environment, and hearing sounds' (Falk and Dierking, 2012: 114).

The factors that impact learning include the novelty of the setting, the pre-visit planning and follow-up work, the degree of structure and the students' control level over the process (Anderson et al., 2006; Balling and Falk, 1980; Berry, 1998; Bitgood, 1989; DeWitt and Storksdieck, 2008; Gottfried, 1980; Griffin, 1998a; Griffin, 1998b; Griffin, 2004; Harrison and Naef, 1985; Hooper-Greenhill, 1991; Orion, 1993; Price and Hein, 1991; Richter, 1993). Students gain most from a field trip when there is pre- and post-visit work in the classroom for students to activate and build on prior knowledge (Anderson et al., 2006). And having control level in unguided or minimally guided instruction (Kirschner et al., 2006; Schmidt, 2000) over the learning process and the outcomes, which should be structured around student needs (Leary, 1996), has a positive impact on their learning.

However, Hein (2006) questioned the transfer of authority from the museum to the students and the interest in making use of 'the creative impulses' they might have (2006: 5). Students' interpretations are subjective, diverse and open to negotiation (Hooper-Greenhill, 1999: 70). That is because the reality that allows them to create and share their own interpretations, and stories alongside the museum narrative (Fisher et al., 2008), is not one-sided. On that note, Runnel and Pruulmann-Vengerfeldt (2012) differentiated between participants and non-participants in the learning process and identified the risk of marginalising or emphasising some visitor stories over others. That means that the ways visitor-generated content is produced, used and distributed is also open to negotiation.

According to Metz (2005), 'teachers [still] need to find innovative ways to use field experiences in a more authentic context' (2005: 169); most likely because programs remain dependent on curriculum-aligned outcomes and activities. Museum objects can be understood and appreciated from a variety of disciplines and points of view (Gartenhaus, 1997). Studies of museum school trips showed the importance of allowing students 'to determine their own areas of inquiry' (Griffin, 2004: 66) during museum explorations. The constructivist museum does allow students to 'construct personal meaning, have genuine choices, encounter challenging tasks, take control over their own learning, collaborate with others, and feel positive about their efforts' (Paris et al., 1998: 271). Hubbard (2015) is also in favour of allowing students to move

around freely, explore and learn by observations. 'Museum experiences are personal, meaning-making processes and products' (Chang, 2006: 184) and '[t]he goal is to create an *experience*' (Wyman et al., 2011: 464, italics in original). But even though this approach 'ensures that the user's voice is at the heart of the museum experience' (Black, 2012: 11), it remains unclear whether an experience, which is self-directed and prompts a creative response, can leave all visitors, particularly students, with a sense of worth and ownership.

At the same time, there is a growing scientific interest in how stories, and particularly digital stories (Wyman et al., 2011), create avenues to objects' interpretation and content exploration inside the museum. A digital story is a two-to-five minutes long self-recorded audio narration of 250-350 words on video format, weaved with photographs, videos, animations, background sounds and/or music (Lambert, 2006). In inquiry-based museum learning, students' interpretation efforts are treated as a quest for personally relevant meaning-making (Hapgood and Palincsar, 2002). A digital story can show us how students make sense of a concept or an experience in the museum because it can expose their understandings and interpretation efforts (Andrews and Donahue, 2009). It is therefore worthwhile to examine how they customise museum investigations, having control of the learning process and the outputs. Research should examine students' perceptions of museum explorations (customised by questions of personal interest, giving them control of the learning process and the outcomes) to gain insights into how they construct meaning following their own interpretative and learning pathways. This study situates itself in the context of organised school visits, during which students work in (small) groups to look for answers to their own pre-determined questions about the museum content. When working in group inquiries students reflect on their decision-making choices throughout the process (Pedaste et al., 2015) and adjust to the demands of group work accordingly, taking responsibility for accomplishments (Chinn and Malhotra, 2002). By framing students' museum inquiries around a story, we can investigate how they engage in cultural heritage interpretation, how they contribute to the museum narrative their own stories, and therefore how they personalise learning in the constructivist museum.

### 1.3 Research objectives and methodology

Within social epistemology (Fuller, 2002; Goldman, 2002; Longino, 1990), following an interpretivist approach and in line with naturalistic inquiry (Lincoln and Guba, 1985; Salkind, 2010), this study explores how the digital storytelling process could frame students' museum inquiries, examining student perceptions of the benefits and the limitations, and the impact on research skills development. While the literature review (see section 2.4) exposed the in-principle connections between inquiry-based learning and learning by crafting a digital story, it was necessary to test these in practice to verify their practicability. The two processes have many points of contact that if combined can frame students' museum inquiries in a story-driven way that favours personalised meaning-making. I developed the *DiStoMusInq* framework (see table 2.5) to articulate the three-staged mapping between the two processes. The rationale behind the framework is justified in terms of the joint focus on research skills development and the potential synergies between researching a collection and researching for a digital story.

The research objectives were to test the framework and explore possible answers to the following research questions:

1. What happens when we use digital storytelling to frame students' inquiry-based museum learning? What are the benefits for students' research skills development and what are the limitations as reported by both students and teachers?
2. What principles should guide the design of effective instructional interventions that use digital storytelling to frame museum investigations?

A series of three interventions was planned and tested in Pinewood the American International School of Thessaloniki in Greece with a total of 70 students. The first trial included a class of 26 Grade 8 students of the Art History subject; the second trial was with a class of 20 Grade 6 students of the Information and Communication Technologies Literacy subject; and the third

trial was with a class of 24 Grade 10 students of the English Literature subject. Three museums were chosen for the on-visit activities: the Folklife and Ethnological Museum of Macedonia-Thrace, NOESIS the Museum of Technology and Science, and the Victoria and Albert Museum, visiting its digital collection. The requirements for selecting museums were that to have links to the curriculum subjects, to use English for content dissemination and communication, to allow self-directed learning, interaction with the objects and the use of mobile devices and to be reasonably close to the school.

An exploratory mixed-methods research design was developed, and a diverse set of data were collected using both qualitative and quantitative methods (these are detailed in Chapter Three). These aimed to capture both student perceptions of their performance and objective measures of performance, and included: a) pre- and post-visit student questionnaires, b) structured observation, c) photographic documentation, d) reflective field notes, e) a focus group discussion (trial 1) and reflective interviews with the student groups (trials 2 and 3), f) the rubric-based assessment of the digital stories, and g) one pre-visit (in trial 1) and one post-visit (in trial 3) teacher interview. This research design allowed exploration of possible answers to the research questions with data collected from students and their teachers. The findings were fed into a refined version of the *DiStoMusInq* framework and the identification of benefits of its integration with school museum trip planning.

## **1.4 Contributions**

This study has made important contributions to the existing limited literature in the field of inquiry-based museum learning and digital storytelling embedded in Greek private school curricula. Also, it suggests ways in which the field can expand and mature with the addition of three trials in three different museums, stretching the boundaries of digital storytelling applications by demonstrating how it can frame museum investigations. In fact, I have identified contributions on three levels: conceptually, practically and methodologically.



Conceptually, the research shows how the blending of the two processes work and what are the benefits of doing so (for self-initiated and self-directed museum learning and for research skills development). This knowledge feeds back to the literature: a) the identification, understanding and contextualisation of the synergies of the two processes embedded in the Greek private school curriculum; and b) the applied value of having a digital story frame students' museum inquiry for research skills development and as a way of investigating and approaching museum objects [through story-driven personal interpretative pathways with student control over the objectives (their research questions) and the outcomes (their digital stories)].

Practically, the research shows how to implement the *DiStoMusInq* framework in school curricula, strengthening the relationship between the private school and the museum in Greece. This knowledge feeds back to the literature a way of applying the framework using a set of principles for the design of an effective instructional *DiStoMusInq* intervention.

Methodologically, the research adds to the field a set of tools available for future *DiStoMusInq* interventions for the further scrutiny of the framework's practicability. This knowledge feeds back to the literature the development and testing of the instruction and research designs, including the data collection tools, for examining how the two processes work in other similar settings and/or with other similar populations.

Overall, even though the study is exploratory and evolutionary rather than revolutionary, its contributions are important because the *DiStoMusInq* framework can be used to broaden the museum's audience engagement and learning agendas to welcome students' meaning making of the experience, constituting them contributors to the museum narrative.

## **1.5 Thesis structure**

This thesis includes a further seven chapters.

Chapter Two reviews existing literature to provide an overview of learning by crafting digital stories and inquiry-based learning by presenting the processes and relevant studies in the classroom, beyond the classroom and in the museum. More importantly, I explain the need to further investigate the interplay between the two processes, to understand how and to what extent digital stories can frame students' group inquiries in the museum.

Chapter Three turns to the methodology and paints a complete and concise picture of how the instruction and research designs were mapped out and implemented. I explain the rationale of the exploratory mixed-methods research methodology and I present the participants, the settings and the data collection and analysis methods and tools. Finally, I address the limitations and the ethical considerations of the study.

Chapter Four presents the findings of the first trial, which was conducted in Pinewood and in the FEMMTH. I report on the data analysis and explain how the insights relate to the literature.

Chapter Five presents the findings of the second trial, which was conducted in the same school and in NOESIS. I report on the data analysis and review how new insights re-shaped the instruction and research designs.

Chapter Six presents the findings of the third trial, which was conducted in its entirety in Pinewood using the V&A's digital collection. I report on the data analysis and explain how the interpretations relate to the literature.

Chapter Seven draws on the data across the three trials to illuminate how the student groups performed throughout the interventions and substantiate the framework's effectiveness in terms of the study's conceptual, practical and methodological contributions. These insights are then applied to the

framework' refinement, proposing a set of principles for its implementation embedded in the Greek private school curriculum.

In Chapter Eight I present an overview of the outcomes and I provide suggesting directions for future research to broaden the scope beyond school trips to web-based museum visits, which can pave the way for newly envisioned applications of digital stories in the twenty-first century museum.

## Chapter Two

### LITERATURE REVIEW

#### 2.1 Introduction

Two concepts shaped this study in museum learning: learning by crafting digital stories and inquiry-based learning. In this chapter I situate the study within the literature by reviewing the use of digital storytelling for learning in and beyond the classroom, and in the museum. Studies of digital storytelling implemented as an approach to constructivism-based learning are discussed to showcase the positive impact of its use on student performance and skills development. Then I review research about inquiry-based learning and how its integration in and beyond the classroom, and in the museum has furthered existing knowledge about self-initiated and self-directed learning, facilitated by digital technologies. Relevant studies are discussed to showcase the benefits of such an approach. The literature review findings revealed that the two processes have common stages and involve the development of similar skills. This guided me in designing the *DiStoMusInq* framework, which draws in-principle similarities between the two processes, allowing me, therefore, to explore possible answers to the research questions about the use of digital storytelling to frame inquiry-based museum learning.

This chapter begins with section 2.2 that focuses on digital storytelling and explains how it was defined in this study, then describes how it supports the development of a range of skills, including research skills. Next, the section discusses how digital storytelling fits into the museum experience. Section 2.3 focuses on inquiry-based learning and explains how it was defined in this study, then presents how it scaffolds research skills development. Next, the section sets out to explain how inquiry-based learning fits into the museum experience. The chapter concludes with section 2.4, which presents the *DiStoMusInq* framework.

## 2.2 Digital storytelling for learning

### 2.2.1 The origins of (digital) storytelling

The origins of storytelling<sup>1</sup> trace back to ancient mythology and the *epics* (e.g. Homer's *Iliad* and Virgil's *Aeneid*), in which language metrics (symmetry and harmony) were important for memorisation and improvisation during the telling. This aspect of formulaic orality (Parry, 1932; Ong, 1982) influenced how storytelling was analysed in narratological terms (Bal, 1997). Stories were found to have semiotic structures, carrying autonomous signifying entities for specific messages. Every story had a form (i.e. the structure of narrative transmission) and 'components: events, existents, and their connections' (Chatman, 1978: 24). A story was thus understood as 'the semiotic representation of a series of events meaningfully connected in a temporal and causal way [...] through semiotic media: written or spoken language, visual images, gestures and acting, as well as a combination of these' (Onega and Garcia Landa, 1996: 3). Storytelling is now understood as a culture's way of explaining or understanding reality or nature (Fiske, 1990), a way of communicating information to teach (Ackerman et al., 1996; Andrews et al., 2009; Spaulding, 2011; Wright, 1995) and make meaning out of experience (Bruner, 1991; 2004; Schank, 1995).

### 2.2.2 Digital storytelling in the classroom

Since the 1990s a growing scientific interest has been noted in digital storytelling as a student-centred approach to didactic paths across contexts to explore how students present self-constructed knowledge in the form of a digital story (Standley, 2003). As digital technologies are being more and more integrated into the classroom (c.f. Clark and Estes, 1999; Perkins, 1991;

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<sup>1</sup> The word *storytelling* (1709) comes from the Old French and English language of the 1200s-1300s and is a compound word of the noun *story* and the verb to *tell*, meaning an account of something, a narrative of past or fictitious events; the former is from *historia*<*estorie*, meaning the relation of incidents, a chronicle, and it relates to the verb to *see* (past tense ἵσθαι of the Greek verb οἶδα, which means to *know*); and the latter is from the Old English *tellan*<*talo*, later also *tale*, meaning to account, mention in order, narrate, relate, announce (Babiniotis, 2011).

Roblyer, 1996; Roblyer et al., 1997; Shelly et al., 2008), digital storytelling is blending the wit and wisdom of oral and written storytelling with the innovation of technology. Boase (2008) encapsulated this as such:

[D]igital storytelling is essentially the application of technology to this age-old experience of sharing personal narratives and seeking to teach and learn from them. (2008: 2)

Research has found that student-generated digital stories are an effective teaching aid as the crafting process facilitates concept integration and scaffolds the development of digital media literacy skills (Banaszewski, 2002; Davis, 2004; Di Blas and Paolini, 2013; Fulwiler and Middleton, 2012; Kulla-Abbott and Polman, 2008; Leopold, 2010; Liu et al., 2014; Mullen and Wedwick, 2008; Niemi and Multisilta, 2016; Solomon and Schrum, 2007; Sweeney-Burt, 2014; Thompson, 2005), and higher-order thinking skills, including research skills (Alismail, 2015; Abdel-Hack and Helwas, 2014; Czarnecki, 2009a; Czarnecki, 2009b; Ganley and Vila, 2006; Gregori-Signes, 2008a; Gregori-Signes, 2008b; Hathorn, 2005; Hung et al., 2012; Kearney, 2009; Robin, 2006; Teehan, 2006; Yuksel et al., 2011). Studies in history (Barrett, 2006; Borneman and Gibson, 2011; Greenhut and Jones, 2010; Hernandez-Ramos and De La Paz, 2009), social studies (Harris, 2007; Rance-Roney, 2008; Vivitsou, 2015; Vivitsou et al., 2017), science (Eldredge, 2009; Tan et al., 2014), mathematics (Dreon et al., 2011; Gould and Schmidt, 2010) and language arts (Brenner, 2014; Bull and Kajder, 2004; Campbell, 2012; Castaneda, 2013; Cennamo et al., 2010; Daniels and Bizar, 2005; DeVoss et al., 2010; Hafner and Miller, 2011; Hughes and Robertson, 2010; Hyland, 2003; Kajder, 2004; Kajder et al., 2005; Kent, 2016; Landry and Guzdial, 2006; Lowenthal, 2009; Maddine, 2014; Meadows and Kidd, 2009; Miller, 2010; Reinders, 2011; Saunders, 2014; Springer et al., 2004; Stojke, 2009; Stephens and Ballast, 2011; Sukovic, 2014; Sylvester and Greenidge, 2009; Tackvic, 2012; Xu and Ahn, 2010; Xu et al., 2011) showed that student-generated stories have a positive impact on cognitive gains. Digital storytelling achieves this through a series of tasks students engage into in order to conceptualise and craft a story with a specific purpose and format.

According to Lambert (2006), a digital story is a two-to-five minutes long self-recorded audio narration of 250-350 words on video format, weaved with photographs, videos, animations, background sounds and/or music. Digital stories differ from other multimedia-based stories for two reasons. First, because a digital story is an emotionally charged commentary crafted from the personal point of view of the teller embedded with his/her own recorded words; with or without editorial overlay in the script (Rule, 2010). Lambert (2010) explained that the recorded voice of the creator captures the essence of the lived experience because having the voice of the narrator recorded contributes to the story's authenticity. Second, because a digital story is planned to have ten elements in mind, produced and assessed accordingly. These elements are: a purpose, a point of view, its dramatic question, the choice of content, the clarity of voice, pacing, the use of audio soundtrack, the quality of images, video and effects, the economy of details, and the proper use of grammar and language (Robin and Pierson, 2005). Each of these elements gives form to the story's intent and impact. For example, the dramatic question determines the use of visuals (photographs, animations or videos) and text, and the emotional content conditions the use of language and the tone of voice.

Robin (2006; 2008) organised digital stories in three types: historical, personal and instructional (2008: 224). Historical digital stories recount events from the past and unfold hidden aspects of historical significance. Personal digital stories are testimonial or fictional accounts of experience, carrying emotional content. Instructional digital stories aim to convey content-specific information to inform on a concept or phenomenon. Each of these types requires a different approach to planning (information search); resulting in minor changes to the ways the production is done (information collection and/or creation, organisation and synthesis). Nonetheless, the types might overlap (Robin, 2008). For example, a historical digital story can also be personal (e.g. an auto-biographical account) or communal (e.g. migration stories), told either objectively with the intent to inform or subjectively with the intent to prompt an emotional response. In the classroom students have limited access to resources and information unless they use the Internet, which limits their choice of type. But outside the classroom they can visit the library or the museum to collect all kinds of information. This allows them freedom to blend

the boundaries of types and tell the story of how they made sense of an experience based on historical and/or fictional elements, or both.

On that note, Nilsson (2008) added that digital stories can also be dramatic if structured around the 'exposition, conflict, rising action, climax, falling action, resolution' model (2008: 139). This model is based on Freytag's (1863) analysis of drama texts and it portrays how a play unfolds in five acts. The exposition establishes the setting, introduces the characters and presents the theme, which is usually a conflict. The events of the second act build up a tension that leads to a crisis. Then the characters' fortunes change for the worse and the events of act four culminate in a catastrophe in tragedies or a denouement in comedies. The fifth act unwinds the tension and provides closure. A digital story built like a play, with a clear beginning, a middle comprising a series of actions (causally or logically connected rising to a climactic moment), and an end that leaves nothing unanswered, is engaging. This model can be applied to all types of digital stories, particularly to personal and instructional ones because they recount personal experiences or present information from a point of view. In that case, students craft a story that shows how they reached new conceptual understandings in a compelling way.

More recently, Smeda (2014) developed the *eLDiSt* (e-Learning Digital Storytelling) framework to examine the effectiveness of digital storytelling to support students' learning of English, visual arts and science. The framework is an extended version of Lambert's (2010) model, including self-directed web-based searches. Its implementation seemed to have enhanced student engagement as students 'put more effort into their digital stories' (2014: 195). The model aligns with the objectives of this study in terms of student-led classroom work but not in terms of investigations conducted in the museum. Therefore, with my study I tried to expand the above models of digital storytelling by including self-initiated and self-directed museum inquiries in the context of school museum visits. Below I explain how digital storytelling was defined and implemented in my study.



## The digital storytelling process

The digital storytelling was defined as a process with three stages (see table 2.1), which are sequential and complementary, each with two sub-stages. The stages are: planning, production and sharing.

Planning	Set a story idea
	Storyboarding
Production	Collect and/or create information
	Synthesise/edit
Reflection	Share/watch
	Reflect/discuss

Table 2.1: The three stages of the digital storytelling process.

Each stage requires students to exercise digital media literacy and higher-order thinking skills, including research skills. Table 2.2 shows the skills that students exercise in the three stages of the digital storytelling process.

Planning	Define purpose
	Design, plan
Production	Search, select, collect, create
	Analyse, organise, interpret, synthesise, edit, export
Reflection	Share, watch
	Discuss, evaluate

Table 2.2: The skills matched to the three stages of the digital storytelling process.

This process requires students to craft a digital story as a personal commentary of a learning experience with their own recorded words and information. In particular, they start by developing a purpose and determining the point of view and its dramatic question. Next, they collect and/or create the information they need in order to illustrate and communicate the intended

message. They write a script, which they develop into a plot (with a beginning, a middle and an end) and they audio record. Then they edit the story materials (visuals, text and audio content) to produce the digital story in the form of a video. Afterwards, they share their videos with peers to reflect on the learning process evaluating their work in each stage as well as the outputs. Below I explain what these stages and sub-stages are and how they link with the defining elements and models discussed above.

## **Planning**

The planning stage consists of the conceptualisation and planning of the digital story and, as such, is an important stage in the process because it determines (depending on the type of the digital story) how the information collection and/or creation and synthesis of the story materials will be done. It has two sub-stages: set a story idea and storyboarding, which includes drafting the script. Students think about what they know about their topic and retrieve information from prior knowledge (Smeda et al., 2010) to conceive a story idea, with a purpose and a dramatic question, and imagine different scenarios of story development (a task like question-setting and seeking out possible avenues to exploration). Then they use a storyboard (see appendix XIII) to develop their characters and draft the script, including the elements of interaction (e.g. events), in the form of a diagram (Ohler, 2006). The type and topic of the digital story guide the writing task, especially in personal stories, which are constructed from one's own experience (Botturi et al., 2012; Bull and Kajder, 2004; Rebmann, 2012; Lundby, 2008). Students work on revisits of the script, determining its impact with selected wording (Calkins, 1984; Miller, 2010). The planning stage involves practicing higher-order thinking skills as they determine what needs to be collected and/or created to illustrate the story and communicate the intended message and decide how these components will interact with each other. In doing so, they visualise how to bring together the script (text), which will be audio-recorded, with the visuals (photographs and/or videos) and any complementary audio content (sounds and/or music) 'in a logical and orderly sequence' (Sylvester and Greenidge, 2009: 292).

## **Production**

The production stage involves researching, collecting and/or creating story materials, finalising and recording the script, and editing the digital story. The first sub-stage (collect and/or create information) involves practicing research and higher-order thinking skills as students look for and collect story materials according to the story's purpose. The credibility of the digital story, whether fictional or based on facts, depends on the archival research and on how the chosen materials are used (Porter, 2005; Clemens and Kreider, 2011). Students learn how to find resources and gather story materials by reading, writing, taking (or scanning) photographs and/or recording video, and how to determine their relevance (a task like information collection and analysis in inquiry-based learning). Having students collect information from different sources helps them 'become more critically aware of the learning process and their own choices therein' (Reinders, 2011: 3). And material selection supports them 'in developing the skills of visualizing and inferring as they select both literal and symbolic images to convey meaning' (Fries-Gaither, 2010: 11). Then they develop and connect ideas to finalise their script. In doing so, they exercise creative and critical thinking skills because developing a plot (with a clear beginning, a middle and an end) requires 'using inductive reasoning' (Czarnecki, 2009b: 15) and 'a degree of critical awareness -knowing what to leave in and what to omit' (Boase, 2008: 4) for the economy of details. The script is audio-recorded with a mobile device (paying attention to the clarity of voice and pacing). The second sub-stage (synthesise/edit) involves practicing digital media literacy skills, including developing an awareness of the lawful use of copyrighted materials and the protection of intellectual property including their own (Langran, 2005). The visual nature of the digital story (mostly photographs) means that students learn about the characteristics and components of multimedia (Fuhler, 2010). To do so, they make 'decisions about possible combinations of multimedia elements' (Gregori-Signes, 2014: 241), each serving the story's purpose. They use a video editing software to put together the visuals (photographs and/or video) with the audio content (audio narration, sounds and/or music), add titles and credits (citing sources). Then they export the digital story as one video file.

## **Reflection**

The reflection/post-production stage comprises two sub-stages: share and watch the digital stories and reflect to discuss about the learning process and the outputs (McDrury and Alterio, 2003; Yuksel et al., 2011). The digital stories are screened in the classroom (Kajder, 2004; Fries-Gaither, 2010) and students engage in a group discussion, defending decisions, debating opinions and exchanging feedback on achievements and opportunities missed. In doing so, they practice communication skills (Behmer, 2005; Stanley and Dillingham, 2011) and develop meta-cognitive skills (Freidus, 2002; Freidus and Hlubinka, 2002; Gregori-Signes, 2008a; Gregori-Signes, 2008b; Landry and Guzdial, 2006; Sadik, 2008, Yuksel et al., 2011). When digital stories are uploaded into video-hosting websites, annotated or embedded with hyperlinks to prompt synchronous or asynchronous interactions (Miller, 2004; Page, 2010; Page and Bronwen, 2011), students can further discuss about their stories' impact (c.f. Malita and Martin, 2010). But Vivienne (2014) highlighted that online distribution involves the risk of attracting negative comments and exposing sensitive data. Teachers must address digital rights management and set privacy settings to protect and secure students' personal data and work.

### **2.2.3 Digital storytelling beyond the classroom**

Digital storytelling has been established as a research methodology and a teaching aid in and beyond the classroom (Dunford and Jenkins, 2017) and with web-based software and applications its implementation for knowledge acquisition and skills development became easier. Alexander (2011) believes that any device that is portable and connected to the Internet will become 'the ultimate digital storytelling device' (2011: 139), shifting the production and screening of digital stories, both for learning and aesthetic valuing, entirely to mobile devices (2011: 226). Adding a mobile dimension to the digital storytelling process with smartphones, tablets and/or laptops brings new possibilities for exploring further and experimenting with all kinds of digital stories (most likely expanding them too) beyond time and location.

Cao et al. (2010) designed *TellTable* (US), a tablet application that allowed primary students to create characters and imaginary scenarios, inspired by books in the school library, and illustrate them using their own photographs and drawings. Students could then audio-record their stories and listen to them being played out alongside the visuals chosen. The findings showed that students improved their digital media literacy, creative writing and collaboration skills as they took inspiration from each other's stories and from the characters and illustrations of the books available onsite.

Similarly, Wood et al. (2014) designed the *Department of Hidden Stories* (US), a mobile-based game for information searches in the library to support primary students in developing reading comprehension and creative writing skills. Students were able to browse for books of interest, read and contribute their own stories in response as part of a playful exploration. The findings revealed that the game components facilitated hands-on interaction with the books and minds-on engagement with the related concepts.

Another relevant case is the work of Pappamihel and Knight (2016) (US), who asked primary students to create digital stories to showcase how they made sense of the knowledge acquired after having visited a history museum as part of their English Language subject. The focus was on assessing students' language arts skills development and how they processed and internalised the historical information obtained during the museum visit. The findings revealed that digital stories optimised concept integration and facilitated information retention.

These cases show us that digital storytelling can be applied in both formal and informal learning settings. Mobile devices brought new ways of creating digital stories, highlighting the personal aspect of sense-making. In that sense, digital storytelling is not just the report of facts and/or fictional information in digital media. It is a way to personalise content, come to an understanding of it and communicate this internalised knowledge in an engaging way (Porter, 2005). A digital story can show us how students make sense of a concept or an experience in the museum because the semantic structure and its elements (i.e. the collection, selection and synthesis of information) expose students' interpretation efforts (Andrews and Donahue, 2009).

## 2.2.4 Digital storytelling in the museum

Over the last two decades, museums across the globe have implemented storytelling into their agendas for curatorial and learning purposes as storytelling 'seems to constitute an appropriate foundation for designing and experiencing visits to museum exhibitions' (Roussou et al., 2015: 2). Storytelling has been used for communication, interpretation and learning (Glover-Frykman, 2009; Ross et al., 2014), leading to museums being re-conceptualised as narrative environments (Macleod et al., 2012; Roussou, 2001; Walker, 2006). As Bedford (2001) described it '[s]tories are very much the 'real thing' of museums, [...] for museums *are* storytellers' (2001: 33, italics in original). Recently, there is a growing scientific interest in how stories, and particularly digital stories (Wyman et al., 2011), create avenues to interpretation and content exploration because they have emotional resonance and prompt visitors, including students, to engage emotionally as well as intellectually with the objects. As such, stories in all kinds of format are being brought into the museum in different ways to serve different purposes.

One way is to have stories 'bring objects to life' as a communication tool for curatorial purposes. With story-driven exhibition designs, interaction with the objects became more engaging. As Caulton (1998) claimed '[t]here is a purpose behind each display, a story to tell with each exhibit, an idea to unfold in each gallery' (1998: 5). Objects tell stories about their owner(s), function and context, and through these visitors make links to their own objects and memories and they might be led to different associations depending on how the objects' stories are told and interpreted (Dudley et al., 2012). Some examples are: the *Storyteller* application of the Victoria museum (AUS) (Hart and Brownbill, 2015), the *Louhisaari Stories* (FI) of the Futuristic History project (2018), the DECIPHER (2011-2013) project (EU) (Collins et al., 2009; Mulholland et al., 2011; Mulholland et al., 2014; 2015; Wolff et al., 2012), the DIAMOND (2012-2014) project (EU) (Da Milano and Falchetti, 2014), the CHESS (2011-2014) project (EU) (Roussou et al., 2017; Katifori et al., 2016; Vayanou et al., 2012; Vayanou et al., 2014a; 2014b), and the EMOTIVE (2016-2019) project (EU) (Perry et al., 2017, Roussou et al., 2017). These show that the selection and display of museum objects (while leveraging advanced digital

technologies) can be based on story structures, which 'allow visitors to engage with collections and to gain meaningful understanding of museum objects' (Kilfeather, 2013: 106), connecting on a personal level beyond conceptual norms (Springer et al., 2004).

However, treating museum objects as reservoirs of associations structured around a storyline is different from treating them as prompts or objects of interest for visitor-constructed stories (c.f. Galani and Moschovi, 2013; 2015). On that note, Roberts (1997) claimed that stories offered museums ways to constitute visitors, including students, as co-constructors of meaning. So, another way is to allow students to contribute to the museum narrative their own stories; using storytelling as an interpretation and learning tool that enlivens interaction and personalises, and by extension diversifies, learning in the constructivist museum.

When visitors experience a museum that encourages individual narrative construction actively, these narratives are directed not toward the acquisition or receipt of the information being communicated by the museum but rather toward the construction of a very personal interpretation of museum objects and collections. (Ross et al., 2014: 277-278)

Personalisation by eliciting story-based responses offers museums the option to deliver tailored experiences (Hillman et al., 2015; Trinkoff, 2015), which meet different visitor needs and learning styles. By extending the interpretation agenda to welcome visitor-generated stories, the museum becomes a knowledge-building place where young visitors of all ages and backgrounds can make their own interpretations.

The process of constructing a narrative provides the visitor with a clear route to engagement and participation with the exhibit, balancing their personal interests, and opinions with the authoritative factual information in the museum. (Jewitt, 2012: 92-93)

The emotional resonance entices the young visitor's imagination as she retrieves and re-contextualises memories and generates mental images through visualisation. Johnsson (2006) contended that by telling a story people learn how to read museum objects 'by giving them meaning, purpose and context' (2006: 6). The semantic structure stories have serves cognitive

functions that allow associative and reflective learning (c.f. Conle, 2003; Harris, 2007), and support learners in processing and retaining information. They do so because stories illustrate abstract concepts, put knowledge into perspective and aid with the reconstruction of contrived concepts. 'Stories are the most fundamental way we learn. They have a beginning, a middle, and an end. They teach without preaching, encouraging both personal reflection and public discussion' (Bedford, 2001: 33). Beyond outcome-oriented agendas for learning, research should look into visitor-generated stories to better understand how the young visitor makes sense of the museum learning process following her own interpretative pathway as part of 'a deepening and enriching of existing knowledge through embodied experience' (Kirk and Buckingham, 2018: 146).

In the following I present examples of how visitor-generated stories in digital format have enriched the visiting experience and transformed visitors into co-creators of meaning, extending the social role of the museum.

The *Art of Storytelling* (2006) project by the Delaware Art Museum (US) invited visitors to get inspired from the objects and produce commentaries. The first prompt was to read and listen to stories about the artwork. The second prompt was to write and record a story as an interpretive response. The outputs were uploaded as podcasts to a platform and were later used as audio tours. The third prompt was to make illustrations to accompany the commentaries. Findings showed that storytelling allowed visitors to connect with collections in ways that are personally meaningful (Fisher and Twiss-Garrity, 2007) and increased their interest in the objects (Fisher et al., 2008).

Similarly, the *Culture Shock* (2008-2011) project by the Tyre and Wear Archives and Museums (UK) encouraged visitors to share their understandings of cultural heritage in the form of a digital story to enhance cross-cultural understanding and foster social cohesion. Visitors expressed their views about cultural identity and explored all kinds of different meanings attributed to cultural heritage. The digital stories were added to the collection as testimonies and shared online to entice further discussions in cultural



heritage interpretation. By doing so, the collection became more relevant to the community and the visitors' voices were amplified.

The *Object Stories* (2010) project was launched by the Portland Art Museum (US) and invited visitors to record their own stories about the objects and display them on the gallery walls. Touch screens enabled visitors to listen to the objects' stories and a recording booth was used for creating their own stories as a response. Interacting with the objects on physical, emotional and intellectual levels facilitated visitors to re-contextualise the objects, connecting them to personal experiences (Wood and Latham, 2014).

The Cleveland Museum of Art (US) designed *Gallery One* (2013), which consisted of ten interactive displays, including the *Stories Lens*. This display allowed visitors to manipulate, co-create and share stories using the *ArtLens* application, which had two activities: *Tell a Story* and *Find the Origin*. The visitor-generated stories were then added to the collection to enrich the museum narrative, adding to the diversity of stories told and heard in the museum and widening engagement in its social role.

Nordmark and Milrad (2012a; 2012b; 2015a; 2015b) examined whether mobile digital storytelling could support collaborative learning as part of the *CoCreate* (2011-2013) project (SE). Students were given a topic to pursue and were asked to collect story materials about one of the historical events, people or locations, related to their topic. The findings reported high motivation levels, improvement in group work and increased on-task focus and commitment (Nordmark and Milrad, 2015b).

The project *Your Story, Our Story* (2016) was launched by the Tenement Museum (US) and invited students to create digital stories inspired by the collection. Students were asked to study the history of immigration and share personal experiences to contribute to the stock of the museum's migration stories. They chose an object, collected information about the owner(s) through archival research and/or interviews, and crafted a digital story about it. The digital stories were shared online to raise awareness of migration and extend the dialogue on this issue shading light on students' perspectives and personal opinions.

Finally, the *DICHE* (2015-2018) project (EU) proposed that student-generated digital stories be integrated in teaching cultural heritage to enliven

the history lesson and scaffold the development of students' critical thinking, creativity, communication and collaboration skills. A toolkit was developed, including the *DICHE* application, for students to create imaginary scenarios set in cultural heritage sites (Liguori et al., 2018). Nonetheless, linking school curricula to museums in such a way has implications about the nature of the museum experience (onsite or online), the learning process (e.g. student control, student interaction levels, cognitive gains and skills development) and the student outputs (what kind of digital stories).

As these projects show, museums use stories to prompt students to make sense of and re-contextualise objects personally (Callaway et al., 2012; Damiano, 2008; Lombardo and Damiano, 2012). However, even though to some extent the young visitor's role as a content producer has been explored, a lot remains unknown about her role as a contributor to the museum narrative, extending the constructivist role of the museum. Research should further examine students' perceptions of museum explorations (customised by questions of personal interest allowing students to have control of the learning process and outcomes) to gain insights into how they construct meaning following their own interpretative and learning pathways. In that light, in section 2.3 I discuss the inquiry-based learning process, which allows students control over their learning and which is core to the *DiStoMusInq* framework.

## **2.3 Inquiry-based learning**

### **2.3.1 Inquiry-based learning in the classroom**

Drawing on socio-cultural constructivism (Staver, 1998), inquiry-based learning is a student-centred learning approach that encourages conceptual understanding through questioning, searching, experimenting, reasoning and explaining (Audet and Jordan, 2005; Alford, 1998; Bateman, 1990; Friesen, 2009; Kuhn et al., 2000; Lee, 2004; Prince and Felder, 2007; Weaver, 1989). Its origins are in science education studies, where it was developed as a method for teaching science through the scientific process. It is

[T]he art of developing challenging situations in which students are asked to observe and question phenomena; pose explanations of what they observe; devise and conduct experiments in which data are collected to support or contradict their theories; analyse data; draw conclusions from experimental data; design and build models or any combination of these. (Hattie, 2009: 208)

In the last three decades, there has been a concerted effort to study inquiry-based learning (Banerjee; 2010; Bell et al., 2010; Calder, 2015; Hmelo-Silver, 2004; Hmelo-Silver et al., 2007; Hodson, 1988; Kuhlthau et al., 2007; Kuhn, 2005; Kuhn and Pease, 2008; Llewellyn, 2002; Novak, 1988; Saunders-Stewart et al., 2012; Short et al., 1996; White and Frederiksen, 1998; Yeomans, 2011), science education (Cakir, 2008) and discovery learning (Anthony, 1973; Brown and Campione, 1994; Shulman and Keisler, 1966). There are inherent links between inquiry-based learning and the scientific process, as inquiry is used to help students to internalise knowledge through investigation and the collection of data that is then subjected to inference and explanation (Allen et al., 1986; Kyle, 1980; Gallagher, 2006; Rutherford, 1964). The links exist not only in the conceptualisation of inquiry as ‘the process of building understanding through collecting evidence to test possible explanations and the ideas behind them in a scientific manner’ (Harlen, 2014: 10); but also, in the process of undertaking a learning inquiry. Research has shown that inquiry-based learning has a positive impact on knowledge acquisition (Friesen, 2009). Students

[A]sk meaningful questions and follow a path of discovery to construct their own understandings, draw conclusions, create new knowledge, and share their knowledge with others. (Stripling, 2008: 50)

Inquiry-based learning empowers students (MacKenzie, 2016) to develop the confidence and ability to ask the right questions (Wolf and Laferriere, 2009: 36), and supports them to develop research and higher-order thinking skills (Barron and Darling-Hammond, 2008; Kuhn et al., 2000; McGregor, 1994). It achieves this by mirroring the scientific process through several stages that scaffold learners’ scientific inquiry.

Wenning (2005; 2010; 2011) elaborated on the work of Tafoya et al. (1980) and Hassard and Dias (2005) and presented how inquiry learning could be applied in the science classroom in six different ways (discovery learning, interactive demonstration, inquiry lesson, inquiry laboratory, real-world application and hypothetical inquiry (Wenning, 2010: 19)). Each of these ways proposes a different level of sophistication and teacher control, resulting in different levels of research skills development. Outside the classroom it is difficult to frame student group inquiries at the latter levels due to different guidance needs and lack of resources. Nonetheless, the museum is ideal for applying inquiry at the former levels because it allows (guided and unguided) content exploration, interactive demonstration and sometimes controlled experiments as well. Discovery learning is fit for the organised school trip to the museum because students can explore the objects and develop conceptual understandings based on hands-on experiences using the museum's resources with some or minimal guidance. However, even though student inquiries are guided by 'what' and 'how' questions (which are open-ended), the teacher maintains control over the learning process (Wenning, 2011). On that note, Kirschner et al. (2006) had also pointed out that unguided or minimally guided instruction is less effective (than guided inquiry) because it lacks structure and purpose.

In that light, Kuhlthau et al.'s (2007; 2015) *Guided Inquiry* model (open, immerse, explore, identify, gather, create, share and evaluate) proposes that students be given teacher support but have most of the control over the learning process and outcomes when they conduct investigations in the library. Students should get immersed in open-ended inquiries, collect and analyse information on their own (Kuhlthau et al., 2007: 23). By doing so, 'students learn to question, research, draw conclusions, and think for themselves' with less scaffolding as they advance stages (Maniotes et al., 2016: xiii). Even so, Harlen (2014) argued that inquiry-based learning should not be equated with minimally guided instruction; on the contrary, students should be involved in decision-making in every stage of knowledge construction. Kuhn et al. (2000) explained that by constituting students responsible for the learning process they develop the competency to acquire knowledge in ways that they initiated and controlled. Guided inquiry is a way to apply inquiry in the museum at the

discovery level because the constructivist museum can host self-initiated and self-directed explorations. However, in the context of the organised school visit it remains unclear how to best frame their group inquiries when they are in control of both the learning process and outcomes.

Pedaste et al. (2015) analysed inquiry-based learning models across contexts and produced a five-stage learning cycle: orientation, conceptualisation, investigation, conclusion and discussion (2015: 54). In the first stage, students explore a topic by reading about it or observing it. The second stage is divided into two sub-stages, questioning and hypothesis generation. This differentiates between forming a question for exploration (inductive approach) or a question for experimentation (deductive approach). Students either make discoveries without hypotheses in mind or they look for evidence to confirm or reject their hypotheses. Then they interpret the collected information to draw conclusions, integrating different pieces of knowledge into an answer. In the discussion stage students present their findings and reflect. This learning cycle could support guided inquiry at the discovery level in the museum because it allows the systematic and planned data generation that is not necessarily driven by a hypothesis. It provides students with a structure to pursue answers to open-ended questions and engage in hands-on material exploration, remaining in control over the learning process and outcomes. This extends museum inquiries beyond science-related subjects to different contexts such as history or visual arts.

### **The inquiry-based learning process**

To set the frame of this study, the inquiry-based learning process was defined as a process with three stages (see table 2.3), which are sequential and complementary, each with two sub-stages. The stages are: questioning, information gathering, analysis and inference, and reflection.

Questioning	Explore/ask
	Plan investigation
Information gathering, analysis and inference	Collect and/or create information
	Analyse/interpret/synthesise
Reflection	Present/report
	Reflect/discuss

Table 2.3: The three stages of the inquiry-based learning process.

Each stage requires students to exercise corresponding research skills (see table 2.4) such as plan the investigation, collect and synthesise data.

Questioning	Define question
	Design, plan
Information gathering, analysis and inference	Search, select, collect
	Analyse, organise, interpret, synthesise
Reflection	Share, present
	Discuss, evaluate

Table 2.4: The skills matched to the three stages of the inquiry-based learning process.

This process gives students control over the learning process in each stage and it allows them to set questions for investigation via exploration (not experimentation) at the discovery level with minimal teacher guidance. In each stage and sub-stage, research skills are not addressed for their own sake. Rather, they are practiced alongside higher-order thinking skills to further the inquiry-based museum learning process. In particular, students ask questions of personal interest about the exhibition and look for information (e.g. read, look closely, take notes). They select and collect information that is relevant to their question(s), which they analyse, organise, interpret to reach new conceptual understandings and synthesise these into an answer. The answers

are then discussed with peers. Below I explain what these stages and sub-stages are and how they link with the models discussed above.

## **Questioning**

This is the stage in which students formulate questions that are worthy of investigation and plan their research and, as such, is the cornerstone of self-initiated learning (Becker, 2000). The first stage has two sub-stages: explore a topic to get familiar and enthused with it to conceptualise questions of interest and plan the investigation. 'The main goal is to open students' minds and stimulate their curiosity' (Maniotes et al., 2016: 10). In order to form questions, they read about their topic and think about what they know, what they would like to know and how. 'As they build background knowledge, students reflect on ideas that matter to them and are worth further investigation' (Maniotes et al., 2016: 10). Equally important to raising questions is selecting questions to be answered by exploration (Littleton, 2002). Prior to the museum visit students determine what needs to be known by identifying sources for information search within the museum (or others such as the library or the Internet). This stage corresponds with the 'open, immerse, explore' stage of Kuhlthau et al.'s model (2015) and the 'orientation and conceptualisation' stage of Pedaste et al.'s cycle (2015) as it allows students to approach a topic open-mindedly and decide for themselves with some or minimal guidance how to conduct their investigation.

## **Information gathering, analysis and inference**

This stage involves the collection, organisation, analysis and interpretation of information. It has two sub-stages: collect and/or create information and analyse/interpret/synthesise. It corresponds with the 'identify, gather, create' stage of Kuhlthau et al.'s model (2015) and the 'investigation and conclusion' stage of Pedaste et al.'s cycle (2015). Having identified sources, they locate information, read it to assess its relevance and accuracy (e.g. recognise connoted meanings, figurative language, imagery, etc.), take notes (e.g. paraphrase, summarise, illustrate), detect common or contrasting ideas, and

organise pieces of information based on shared characteristics. In the museum, students also hone visual literacy skills as they practice aesthetic valuing and artistic perception. In the second sub-stage, organising the information helps students make decisions about what information is important to keep and relevant to their topic (Maniotes et al., 2016). At the same time, they learn to keep clear records of their work to be able to cite their sources and defend later how they drew conclusions, as part of building 'student ownership' (Calder, 2015: 1122). The interpretation and synthesis of the information in a logical argument requires students to use their reasoning and critical thinking skills (Stepien and Gallagher, 1993). Students draw conclusions based on reasoned arguments, which demonstrate how they reached new conceptual understandings.

Analysing and interpreting results means going further than collecting individual observations and recording them. It means trying to find patterns that relate various pieces of information to each other and to the ideas being tested. (Harlen, 2014: 16)

Students use the results of their analysis to make sense of the newly acquired information and revisit prior knowledge, putting interpretations together as informed answers to their questions.

## **Reflection**

The reflection stage involves the presentation and discussion of the findings, and it has two sub-stages: present/report and reflect/discuss. This stage corresponds with the 'share and evaluate' stage of Kuhlthau et al.'s model (2015) and the 'discussion' stage of Pedaste et al.'s cycle (2015) as students present the findings in an articulate and comprehensive way and discuss with peers how and why they came to new understandings. In reporting their findings, students need to be aware that existing beliefs might impact their inferences and undermine their conclusions (Kuhn, 2005). To avoid doing so, they should evaluate their interpretative efforts through self-reflection and feedback-exchange, in line with recommendations for structuring cooperative work (Gillies, 2003). They 'question each other, ask for explanations as well as descriptions and suggest improvements in what was done' (Harlen, 2014:



17). By doing so, they externalise knowledge, develop critical thinking and confidence in their ability to defend their opinions.

### **2.3.2 Inquiry-based learning beyond the classroom**

The affordances of advanced digital technologies, and particularly mobile devices, to support inquiry-based learning in and beyond the classroom have been studied systematically (Ally, 2009; Anastopoulou et al., 2008; Attewell, 2005; Avraamidou, 2008; Buckner and Kim, 2014; Edelson et al., 1999; Jones et al., 2006; Jones et al., 2013a; Jones et al., 2013b; Patten et al., 2006; Pedaste and Sarapuu, 2007; Pietrzuk et al., 2011; Seol et al., 2011; Scanlon et al., 2011; 2012). Studies in science (Kalz et al., 2014; Levin and Tsybulsky, 2017; Looi et al., 2011; Looi et al., 2015; Song et al., 2012; Vogel et al., 2010), biology (Beishuizen et al., 2004; Mäeots et al., 2008; 2011; Mäeots and Pedaste, 2014; Laru and Järvelä, 2008; Laru et al., 2012; Zacharia et al., 2016), social sciences (Shih et al., 2010), geography (Chang et al., 2012; Medzini et al., 2015) and language arts (Chen and Hsu, 2008) showed that the use of mobile devices increases engagement, having a positive impact on cognitive gains (Hwang et al., 2013; Liu et al., 2014; Sung et al., 2016) and research skills (Ahmed and Parsons, 2012; 2013; Song, 2014).

The *Personal Inquiry* (2007-2010) project (UK) examined the use of the *nQuire* toolkit to set up hypotheses, conduct experiments and engage in debates (Anastopoulou et al., 2008; Anastopoulou et al., 2012; Conole et al., 2008). The project aimed to explore how the toolkit, and its scripts (Scanlon et al., 2011), could support students in initiating investigations based on their interests (Mulholland et al., 2012). The findings showed that students became aware of the challenges associated with fieldwork that was guided by personal questions (Anastopoulou et al., 2012).

Another relevant case is the *SMILE* (Stanford Mobile Inquiry-based Learning Environment) (2011-2013) project (US). Students were asked to generate questions to assess what they had learned, respond and rate the questions asked. The project aimed to support students in developing skills related to questioning, critical thinking and collaboration. The findings showed that 'students' questioning skills developed over time' (Buckner and Kim, 2014:

114) and that group work was reinforced as students assessed the quality of their peers' questions and responses.

The *weSPOT* (2012-2014) project (EU) examined how students provided with a web-based learning platform conducted investigations in scenario-driven contexts. Students used the platform to set up group inquiries, choose data collection methods, collect photographs, audio and video, present findings and rate learning outcomes (Mikroyannidis et al., 2013). The findings showed high engagement levels and positive attitudes toward the use of the platform (Peltekova et al., 2014).

Not only do mobile devices personalise the investigation and facilitate student interaction, but they also disassociate it from time and location and increase access to 'authentic phenomena outside the classroom' (Eliasson, 2012: 92). For example, they can use 'their smartphones to take pictures, video their surroundings, or use the voice recorder to reflect on what they saw' (Maniotes et al., 2016: 2). Students using smartphones or tablets can conduct investigations at the discovery level with minimal teacher guidance outside the classroom at their own pace following their own learning pathways.

### **2.3.3 Inquiry-based learning in the museum**

Ever since Ansbacher (1999; 2013) associated the experience of visiting a museum with question-driven explorations, researchers became enthused with the museum's potential to assimilate the laboratory (Griffin, 1998; Metz, 2005; Sauber, 1994) and be a place of research, knowledge construction and acquisition (Johnson and Quinn, 2004) where students' inquiry skills could be put into practice (Allen and Gutwill, 2009; Gutwill and Allen, 2012; Russell, 1994). Studies showed that hands-on and minds-on experiences facilitate concept integration and achievement in science through exploration, experimentation and interaction with the objects and others (Borun, 1983; Braund and Reiss, 2006; Carlisle, 1985; Holmes, 2011; Mcleod and Kilpatrick, 2001; Pedretti, 2004; Perry, 1992; Salmi, 2003; Schauble et al., 2002; Sorensen, 2003). In inquiry-based museum learning, students' interpretation

efforts are treated as a quest for personally relevant meaning-making (Hapgood and Palincsar, 2002).

Recently, there has been a lot of enthusiasm for the ways advanced digital technologies can support the constructivist museum, transforming it a place where visitors, including students, 'are free to question, debate, collaborate, and speculate (seeking out those issues that most concern them), and are given the support and inspiration required to do so' (Black, 2012: 11). Digitised collections, multimedia kiosks, smart environments and mobile-supported applications enrich the visiting experience, extending this engagement beyond space and time (Allen and Lupo, 2012; Parry, 2010; Smith-Bautista, 2013; Tallon and Walker, 2007; Thomas and Mintz, 1998). Researchers (Anderson, 2012; Parry, 2007; Witcomb, 2003) have been looking into the ways advanced digital technologies exposed new avenues to curatorship, interpretation and learning, without neglecting that these might favour interaction with the objects over interaction among people (Katifori et al., 2016; Wessel and Mayr, 2007). Spalding (2002) argued that exhibition design should succumb neither to a neat, scholarly yet uneventful display, nor to a thrilling, interactive yet uninspired representation of the past.

In the following I provide examples of how museums have implemented inquiry that is technology-supported into their interpretation and learning agendas to transform young visitors into explorers of the museum content.

The *Exploratorium: Institute for Inquiry, Museum of Science, Art and Human Perception* (US) designs experiences that challenge students to experiment and expand their thought processes. Research was conducted (Gutwill and Allen, 2010; 2012) to understand how inquiry-driven games can facilitate this. The findings indicated that visitors made more sophisticated proposals for action, spent more time in the exhibitions (Gutwill and Allen, 2010; Gutwill and Allen, 2012) and 'conducted more investigations that built on each other in a coherent way' (Allen and Gutwill, 2009: 298).

The *Experimentarium* (DK) operates with a similar rationale. Its mission is to transform the way young visitors experience and learn about science and

technology by stimulating their curiosity and senses, evoking emotions and enticing them to ask questions (Falk and Gillespie, 2009). The learning programs complement the school curriculum with technology-supported experiments, competitions and activities. Students interact with the objects, read, play and test out their ideas to understand more about their topic of interest by themselves.

The project *MyArtSpace* (2005-2007) (UK) investigated the scaffolding of museum inquiries through pre-visit exploration of the inquiry question, on-visit information gathering, and post-visit information analysis and question answering through the curation of online student galleries (Vavoula et al., 2009). The project aimed 'to connect and guide learning between the classroom and museum, while allowing students to create their own interpretations of the visit through active inquiry' (Sharples et al., 2007: 238). The findings showed that the platform 'was effective in enabling students to gather information in a museum' and connect the visit with classroom learning (Vavoula et al., 2009: 286), and it had a positive impact on the experience as high levels of engagement were noted (Sharples et al., 2007).

Kuhn et al. (2010) and Cahill et al. (2011) developed *Zydeco* (US), which was used to support students in conducting investigations in museums. Students formed questions and they used mobile devices in the museum to collect text, photographs and videos (annotated with labels and voice comments), which they used back in the classroom to construct explanations. The findings showed that they could 'conduct mediated multimodal data collection' (Cahill et al., 2011: 23), they spent more time interacting with the objects and they held meaningful peer conversations (Lo et al., 2013).

Marty et al. (2013) presented the *Habitat Tracker* (2010-2012) project (US), which aimed to identify design principles for an application for data collection during museum field trips. Students were put in groups and were asked to use the application to raise questions and during the museum visit to collect information, analyse it and present the investigation outcomes in written reports. The findings revealed that the application supported students' efforts to record observations and collect data during the museum visit (Marty et al., 2013: 47). The design recommendations were to offer navigation controls,

implement more graphics and visual elements and simplify tasks in the inquiry-based learning process (Marty et al., 2013: 64).

Muratsu et al. (2014) developed the *Stamp-On* system (JP) for mobile devices to support students' inquiry work in the museum. Students used tablets and placed stamps on the exhibits they found relevant. The system detected the stamp pattern and displayed the corresponding explanations (visuals and text). The findings showed that the system was an effective teaching aid because students could then identify the museum objects correctly (Ishiyama et al., 2014; Muratsu et al., 2014).

Finally, the *MuseumScouts* (2006-2008) project (EU) aimed to integrate advanced digital technologies to connect inquiry-based learning at school with the museum. During the museum visit students used *Evolution*, an online tool, to collect information (text and visuals) related to their assigned topic. Back in the classroom, they collaborated to create multimedia presentations in order to inform and quiz their peers. The findings showed that students improved their data collection and analysis skills and benefited from testing each other's knowledge (Wishart and Triggs, 2010).

These cases exposed ways museums employ inquiry for self-directed discoveries supported by advanced digital technologies and mobile devices and linked with learning in the classroom (c.f. Cabrera et al., 2005; Hsi, 2004; His and Fait, 2005; Lo and Quintanta, 2013; Maher, 2015; Papadimitriou et al., 2006). In their majority, these examples do not permit students to set their own questions to be investigated in the museum following their own interpretative and learning pathways. And they do not expand on student perceptions of the experience in terms of benefits and limitations, particularly looking into how students perceive the museum inquiry's impact on their research skills. There is a need for a framework, which would enable students to customise museum investigations based on questions of personal interest, and construct knowledge on their own, having control of the process and outputs. Next, I present the *DiStoMusInq* framework, which enables students to do just that.

## 2.4 The *DiStoMusInq* framework

The literature reviewed herein pointed to the need for exploring further how students make sense of objects and concepts in self-initiated and self-directed discoveries in the museum; and how digital stories can structure these interpretations (Chang, 2006; MacKenzie, 2016; Silverman, 1995).

Research shed light on how students use mobile devices to customise their explorations and contribute with multimedia responses such as text on digital format, photographs or audio/video recordings (Cahill et al., 2011; Collins et al., 2009; Vavoula et al., 2009). Research also showed that story structures enrich engagement and facilitate concept integration and skills development (Avraamidou, 2013; Avraamidou and Osborne, 2009; Conle, 2003; Kinsey and Moore, 2015; Negrete, 2005; Negrete, 2009; Negrete and Lartigue, 2010; Prins et al., 2017). However, to date few studies explored digital stories as creative outputs of museum-related literacy programs (c.f. Whitelaw, 2017) that integrate inquiry-based learning in and beyond the classroom. One example is the work of Murmann and Avraamidou (2014a; 2014b; 2016), which examined how students engaged in group investigations in the museum structured around a pre-determined story to find solutions to an imaginary conflict as part of their science lesson. High levels of motivation and increased interaction with the objects were reported but poor connection was found between students' investigative practices and the crafting of the digital stories (Murmann and Avraamidou, 2016). It is thus worthwhile to examine whether self-initiated inquiries (driven by questions of personal interest) could strengthen the connections between their investigative practices and the story production, especially when students create their own stories as an outcome of such investigative practices in the museum.

On that note, studies of museum school trips showed the importance of allowing students 'to determine their own areas of inquiry' (Griffin, 2004: 66) during museum explorations. 'Museums can put [student] minds into motion without pre-determining their destination' (Gartenhaus, 1997: 45). The constructivist museum does allow students to construct personal meaning, take control over their own learning (Paris et al., 1998) and respond creatively,

showing how they made sense of the experience in their own terms. Nonetheless, museum educators have not employed digital stories as a frame for students' inquiry-based learning, allowing students control over the learning process and outcomes. Yet, digital stories (e.g. personal and/or instructional) appear to have a likelihood of fit with inquiry-based museum learning. An explanation for this was attempted to be given by this study, which examined how digital stories can frame museum investigations, examining student perceptions of the benefits and the limitations, and the impact on their research skills development.

I developed the *DiStoMusInq* framework (see table 2.5) combining the digital storytelling process (see table 2.1) with the inquiry-based learning process (see table 2.3). I wanted to explore and examine how students conceptualise investigations based on questions of personal interest, collect and analyse information, and craft a digital story (with the ten elements and a well-structured plot) that presents the answers to the questions they had set. The rationale behind the framework is justified in terms of the joint focus on research skills development and the potential synergies between researching a collection and researching for a digital story. The two processes have many points of contact that if combined can frame students' museum inquiries in a story-driven way that favours personalised meaning-making.

As discussed above, various models of inquiry-based learning have been proposed, featuring a set of stages (questioning, investigation and interpretation of findings, and reflection) that require and cultivate a set of research skills. 'Inquiry demonstrates ways of examining and explaining objects, responses, and phenomena, and encourages learners to generate their *own* ideas and meanings' (Gartenhaus, 1992: 3, italics in original). The *DiStoMusInq* framework proposes the framing of these ideas and meanings by a digital story because the stages of the digital storytelling process (planning, production and reflection) have in their majority corresponding tasks, which require students to exercise and develop a similar set of skills. To be more specific, students involved in museum inquiries at the discovery level guided by questions of personal interest (self-initiated) and conducted with some teacher guidance allowing them control over the learning process and

outcomes (self-directed), engage in activities of information search, collection and analysis to reach new conceptual understandings about the museum topic of investigation. Similarly, students involved in the crafting of a digital story that has the defining elements and a well-structured plot (with a clear beginning, a middle and an end that leaves nothing unanswered) also engage in activities of information search, collection and analysis to produce story materials. These tasks reflect higher-order thinking skills and research skills, which correspond. Thus, I focused on research skills synergies because in the first (questioning/planning) and second stages (information gathering, analysis and inference/production) of the two processes the students perform similar tasks.

<b>Inquiry</b>		<b><i>DiStoMusInq</i></b>	<b>Digital Storytelling</b>	
Stages	Skills	Stages	Skills	Stages
Questioning	Topic exploration and selection Question-setting	1a Conceptualise	Set a story idea Type selection Define purpose (dramatic question)	Planning
	Investigation planning	1b Plan and manage	Storyboarding Draft script	
Information gathering, analysis and inference	Information searching, selection, collection/creation	2a Data collection and generation	Information searching, selection, collection/creation	Production
	Information analysis, organisation, interpretation and synthesis	2b Analysis and synthesis	Information analysis, organisation, plot development and editing	
Reflection	Present Reflect/discuss	3a Sharing 3b Peer review and reflection	Share and watch Reflect/discuss	Reflection/Post-production

Table 2.5: The *DiStoMusInq* framework.

The first stage of the *DiStoMusInq* framework has two sub-stages: 1a) conceptualise the museum investigation and 1b) plan and manage inquiry work. Students set a question of personal interest after an initial exploration of the exhibition with some teacher guidance and think of how they will search for relevant information. Then they develop a story idea, determining the purpose and point of view, and use the storyboard to draft their script and plan the collection and generation of story materials.



The second stage of the *DiStoMusInq* framework has two sub-stages: 2a) data collection and generation, and 2b) analyse and synthesise the story materials to craft a digital story. During the museum visit, students use their own mobile devices to gather information for their investigations and create story materials for their digital stories (by reading, note-taking, taking photographs, recording audio and/or video). They locate and select the materials that will communicate the intended message of the story. Back in the classroom they put together the story materials (editing) to present the answers to their inquiries and illustrate the acquired knowledge.

The third stage of the *DiStoMusInq* framework has two sub-stages: 3a) sharing and 3b) peer review and reflection. Students watch their videos with peers and engage in group discussion to reflect on both the learning process and their creative outputs as evidence of sense-making and skills development.

The *DiStoMusInq* framework guided the instruction and research designs employed for a series of three trials, which showed how the mapping of digital storytelling on the inquiry process in the museum worked. This meant that it played a dual role: as a framework for the in-class interventions and as a framework for the research design in this study. In fact, the conceptual framework helped clarify the nature of the inquiry as exploratory and guide the instructional procedure; particularly the design and implementation of the three trials (e.g. lesson plans, learning objectives and student classroom-and-museum-based activities). And it was used to guide the data collection procedure, particularly the design of the data collection tools (e.g. student questionnaires and the rubric for assessing the digital stories). By doing so, I was able to explore slightly different avenues to inquiry in the instructional procedure, having the framework as the common denominator.

## **2.5 Summary**

This chapter set out the theoretical ground for the study presenting the two approaches taken: learning by crafting digital stories and inquiry-based learning. Section 2.2 explained the digital storytelling process and how it

supports learning in and beyond the classroom, and in the museum. Section 2.3 explained the inquiry-based learning process and how it fits into the museum. Section 2.4 presented the *DiStoMusInq* framework, which aimed to examine how digital storytelling can frame students' group museum inquiries.

## **Chapter Three**

### **RESEARCH METHODOLOGY**

#### **3.1 Introduction**

The chapter starts with the research objectives described in section 3.2. Section 3.3 is a discussion of the methodological approach I took. Section 3.4 presents the research settings. Section 3.5 discusses each trial's instruction design. Section 3.6 explains the rationale behind the research design and the data collection tools. Section 3.7 presents the data analysis procedure. Section 3.8 responds to the limitations of the study. The chapter ends with section 3.9 discussing the ethical considerations and the measures taken to ensure that the trials were carried out conscientiously and responsibly.

#### **3.2 Research questions**

This study explores how digital storytelling and inquiry could sit synergistically side-by-side in an integrated learning intervention and how this mapping contributes to students' research skills development. I developed the *DiStoMusInq* framework (see table 2.5) to articulate the three-staged mapping between the two processes, examining student perceptions of the benefits and the limitations, and the impact on research skills development.

The research objectives were to test the framework and explore possible answers to the following research questions:

1. What happens when we use digital storytelling to frame students' inquiry-based museum learning? What are the benefits for students' research skills development and what are the limitations as reported by both students and teachers?
2. What principles should guide the design of effective instructional interventions that use digital storytelling to frame museum investigations?

### **3.3 Methodological approach: exploratory mixed-methods research**

Within social epistemology (Fuller, 2002; Goldman, 2002; Longino, 1990), this study focused on procedures rather than objectives. And in line with naturalistic inquiry (Lincoln and Guba, 1985; Salkind 2010), I followed an interpretivist approach, asserting that there is no single reality to be observed and no single interpretation to be made in a deterministic fashion (Howe, 1985; Ratner, 2008). Stebbins (2001) explains that exploratory research is appropriate in the preliminary stages of investigation, not for diagnostic purposes but for the purposes of systematically trying to gain an understanding of the research context. In this sense, this study is exploratory, meaning that the ‘research *process* itself’ guided me toward examining possible avenues to understanding (Corbin and Strauss, 1990: 6 italics in original).

The study combined methods (Gorard and Taylor, 2004) ‘and/or types of data to study the same research question[s]’ (Fraenkel et al., 2012: 559) and to build the foundations for subsequent research (Neuman, 2014). The instructional and the data collection procedures were designed side by side; allowing the findings to guide the process and account for the interpretations made (Corbin and Strauss, 1990; Mason, 1996; Yin, 2003; 2009; 2011). These accounts were based on a descriptive and interpretative analysis of the quantitative and qualitative data. By doing so, I had the flexibility to feed the findings of each trial into the design of the next trial (without having to pre-determine that the procedures will necessarily run the same for all trials). My decision to take this interpretivist approach aligned with social research as well as with reflexive methodology (Alvesson and Skoldberg, 2000).

### **3.4 Research settings**

#### **3.4.1 The school and the participants**

I was interested in private schools in Thessaloniki in Greece (because it is my place of residence and work), whose curricula included inquiry-based learning and museum visits, and where mobile devices could be used in the classroom. If the research was run at a non-inquiry school, students would need to learn

both how to do inquiry and how to do digital storytelling; thus, skewing our view of whether any observed impacts were owing to the introduction of the inquiry or of the digital storytelling. One private school fulfilled these requirements and was successfully recruited (see appendix XII): Pinewood - the American International School of Thessaloniki. I worked at Pinewood as a substitute English Language teacher during the academic year 2012-2013 and I was familiar with the curriculum. Pinewood is an independent, non-profit, co-educational international school established in 1950. It offers the American college-preparatory curriculum and the International Baccalaureate Diploma program<sup>2</sup>, which both allow students to make use of personal past experiences to reach newer knowledge through curiosity, critical thinking and creativity (IBO, 2008). That is why the school community visits museums regularly.

The requirements for selecting the subjects, and subsequently for recruiting participants, were to have a provision for museum visits and have inquiry-based learning strongly featured in the syllabus. Generally, students have adequate command of the English language (i.e. at least A1-A2<sup>3</sup>), come from different countries around the world, including Greece, and have good levels of literacy and digital (media) literacy. My working experience suggested Grades 6 to 12. That is why I focused the sampling on secondary education, and particularly students enrolled in middle school and high school. There was no conflict of interest because the Grades 6 to 12 students during the academic year 2016-2017 were not my students four years earlier.

Three trials were designed based on Pinewood's inquiry-based learning curriculum, each exploring different ways of using digital storytelling to frame museum inquiries, with a total of 70 students.

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<sup>2</sup> The website of Pinewood the American International School of Thessaloniki (GR). Available at: <https://www.pinewood.gr/en> (accessed January 2016).

<sup>3</sup> English language levels according to the Common European Framework of Reference for Languages: Basic user: A1 Beginner and A2 Elementary, Independent user: B1 Intermediate and B2 Upper-intermediate, Proficient user: C1 Advanced and C2 Proficiency (EU). Available at: <https://www.coe.int/en/web/common-european-framework-reference-languages/level-descriptions> (accessed April 2016).

The first trial included a class of 26 aged 12-14 years old Grade 8 students in Art History. Students work on investigation workbooks based on an art-related theme for which they collect information, take notes and use drawing and/or collage to create their own work as a response. The subject also includes visits to various museums in Thessaloniki related to specific units.

The second trial was with a class of 20 aged 10-12 years old Grade 6 students in Information and Communications Technology Literacy. This subject encourages hands-on cognitive and technical learning as students practice ICT and digital media literacy skills; and it includes a visit to the NOESIS the Museum of Technology and Science in Thessaloniki.

The third trial was with a class of 24 aged 15-17 years old Grade 10 students in English Literature. Students engage in literary analysis of texts about the Victorian Era of the 19<sup>th</sup> century and in compositional writing. There was no provision for museum visits as part of this subject, but it had strong links with the digital storytelling process (story development and analysis), which I thought were worth exploring.

### **3.4.2 The museums**

The requirements for selecting museums and exhibitions to visit were to have links to the subjects (so that learning objectives would fit the syllabus), to use English for content dissemination and communication (for the international students), to promote self-directed learning and interaction with the objects (for students to be free to explore the museum content on their own), to allow the use of mobile devices onsite and to have proximity to the school.

The museum chosen for the first trial was the Folklife and Ethnological Museum of Macedonia-Thrace in Thessaloniki. The FEMMTH was chosen because it was scheduled to visit it as part of the Art History subject's ethnographic heritage unit. The FEMMTH is a non-profit, cultural and educational institution established in 1970. It houses collections and exhibitions of ethnographic heritage of the pre-industrial societies of

Macedonia and northern Greece<sup>4</sup>. A visit to permanent exhibition *At the watermills of Macedonia and Thrace: gristmills, sawmills, fulling mills, cloth finishing waterfalls in traditional society* (see figure 3.1) was fit because students would conduct museum investigations and craft digital stories about the late-19<sup>th</sup> and early-20<sup>th</sup> water-powered mills.

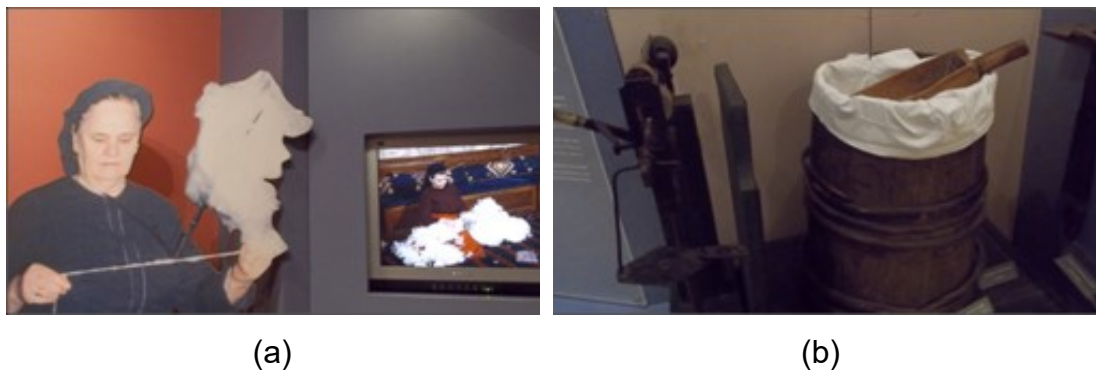


Figure 3.1: Part of the display for the cloth finishing mill (a) and part of the display for the watermill (b) in the exhibition *At the watermills of Macedonia and Thrace* at the FEMMTH.

The museum chosen for the second trial was NOESIS the Museum of Technology and Science in Thessaloniki. NOESIS was chosen because it was scheduled to visit it as part of the ICT subject's unit of technological applications to life. NOESIS is a non-profit, cultural and educational foundation established in 1978. It houses collections and exhibitions about the scientific and technological advancements in Greece and around the world<sup>5</sup>. A visit to the permanent exhibition *IDEA - Ancient Greek Science and Technology* (see figure 3.2) was fit because students would collect information and produce digital stories about technological achievements in the pre-historic period until the Hellenistic and Byzantine periods.

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<sup>4</sup> The website of the Folklife and Ethnological Museum of Macedonia - Thrace (GR). Available at: <http://www.lemmth.gr/en/welcome> (accessed January 2016).

<sup>5</sup> The website of NOESIS the Museum of Technology and Science in Thessaloniki (GR). Available at: <http://www.noesis.edu.gr/en/> (accessed January 2016).



Figure 3.2: Part of the exhibition *IDEA - Ancient Greek Science and Technology* at NOESIS.

For the third trial, I decided to organise an online visit to the Victoria and Albert Museum in London, visiting its digital collection (see figure 3.3). As there was no provision for any museum visit as part of the English Literature subject, the online visit was an innovation that would serve the study's purpose and enrich the syllabus with content-specific knowledge and authentic materials. By choosing it, I added an online museum visit to the research settings, extending the exploratory nature of the study and examining a different approach to a *DiStoMusInq* intervention. The V&A is a non-departmental, cultural and educational institution founded in 1852. It houses a permanent collection of the world's heritage of art and design from ancient to modern times<sup>6</sup>.

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<sup>6</sup> The website of the digital collections of the Victoria and Albert Museum in London (UK). Available at: <https://collections.vam.ac.uk/> (accessed February 2016).



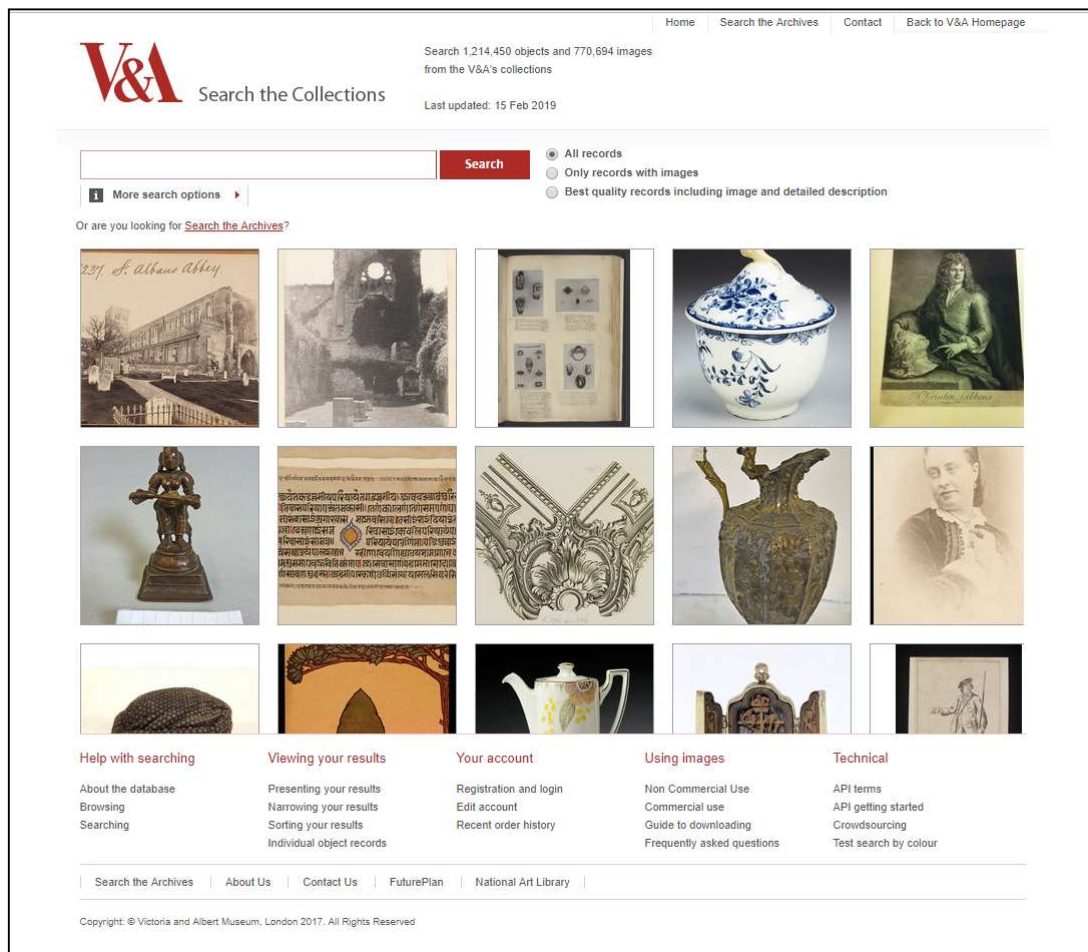


Figure 3.3: Screenshot from the homepage of the *Search the Collections* service of the V&A (accessed July 2017).

The service entitled *Search the Collections* is a database that provides online access to over a million catalogue records for the study of architecture, decorative art including sculpture, photography, furniture, and fashion. The search options include searches by object name, place of origin, artist or maker, date, material or current location in the database. The visual information appears in thumbnail images and clicking one reveals a pop-up with more information such as the category the object belongs to, the name and other references. The museum allows downloading low-resolution images for non-commercial educational use of the content for the purpose of teaching and instruction within an educational establishment. Students would use keywords for their searches to find information about the Victorian Era and craft their digital stories with the returned findings.

### 3.5 Instruction design

This section lays out the instruction design of each trial. Lesson plans were designed for all the lessons (e.g. see appendix V). The parameters that differentiated the three trials were: the subjects, the museums, the students' age, the size and number of groups formed per class, the mobile devices students used, and the sequence and number of the lessons (see table 3.1).

	Time periods	Grade	Subject	Topic	Museum	Student number	Groups formed	Number of lessons	Digital storytelling instruction	Mobile devices used
Trial I	Oct-Nov 2016	8 (12-14 years old)	Art History	Water-powered Mills	FEMMTH	26	9 groups of 3	4	In lesson 2 (before the museum visit)	Smartphones and tablets
Trial II	Mar-Apr 2017	6 (10-12 years old)	ICT Literacy	Ancient Technology	NOESIS	20	4 groups of 4 + 2 groups of 2	4	In lesson 3 (after the museum visit)	Smartphones, tablets and laptops
Trial III	May-Jun 2017	10 (15-17 years old)	English Literature	Victoria Era	V&A (website)	24	8 groups of 3	8	In lesson 2 (before the website visit)	Smartphones and laptops

Table 3.1: The three trials at Pinewood.

In trials 1 and 2, students started with a question and they were introduced to the digital storytelling process *before* the museum visit during which they conducted their museum investigations; whereas in the second trial, students started with a question, conducted their museum investigations and then they were introduced to the digital storytelling process. It was *after* the museum visit that they developed their story ideas and used the materials they had already collected to craft digital stories, which would present the answers to their questions. This variation in the instructional procedure occurred because I wanted to explore a different way of integrating the digital storytelling process into the instruction. This decision allowed exploration of the impact of integrating digital storytelling before or after the museum visit on students' perspectives of their research skills competence levels examining both possibilities. In other words, I could examine how they crafted the digital stories

as a result of planning museum investigations, having or not having the digital story in mind before the museum visit. But the data analysis of the second trial (see section 5.2) showed that this mapping of the two processes did not work as well as the first one and that is why in the third trial, I returned to the way the first trial was designed.

Two resources were used for the in-class student activities: a hand-out (see appendix III) and a storyboard (see appendix XIII).

The hand-out was designed based on a resource guide for teaching with museum collections<sup>7</sup>, which consisted of questions about the properties of an object in terms of function, features, material, construction technique, design, context and value. The intended role of the hand-out was to support students in developing a focus by activating prior knowledge of the inquiry process and making suggestions how to articulate that focus in forming their own questions; as well as to serve as a visual reminder of their information search objectives while collecting the information during the museum visit.

The storyboard was adapted from a template<sup>8</sup>, which had allocated spaces for photographs and text. The adaptations were made to add space for each group's question(s), point of view, emotional intent and what type of information needed to be collected and how this would be assessed before it would be used in the digital story. These changes were made to better fit the context of the inquiry-based learning process and to assist students in planning for their digital stories.

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<sup>7</sup> Teaching with museum collections resource guide 2016 [online]. United States: National Park Service and Management Program, based on the Hands on History Program of the National Museum of American History (US), the Smithsonian Institution (US), the Museum Magnet Schools (US), and the 'A Teacher's Guide to Learning from Objects' of the English Heritage (US) and the Victoria and Albert Museum Education Materials (UK). Available at: [https://www.nps.gov/museum/tmc/docs/How\\_to\\_Read\\_an\\_Object.pdf](https://www.nps.gov/museum/tmc/docs/How_to_Read_an_Object.pdf) (accessed February 2016).

<sup>8</sup> Storyboard template 2010 [online]. Jason Ohler digital storytelling teaching resources (US). Available at: [http://www.jasonohler.com/pdfs/storyboard\\_template.pdf](http://www.jasonohler.com/pdfs/storyboard_template.pdf) (accessed January 2015).

### 3.5.1 First trial

The intervention in the first trial included four lessons: two pre-visit lessons that took place in the classroom, a two-hour museum visit with a follow-up session immediately after the students returned to school, and one post-visit lesson back in the classroom (see table 3.2).

	Lesson duration, setting and date	Lesson description (the instructional procedure)	In-lesson data collection tools (the data collection procedure)				
			SQ	NRL	OF	P	SO
Pre-visit lessons	Lesson 1: 1x60' School 14/10/2016	Students were given an outline of the inquiry-based learning process and they were introduced to the exhibition with the aid of a Power Point presentation (see appendix IV). They developed questions for and planned their museum investigations on the hand-outs.	+	+			+
	Lesson 2: 1x60' School 21/10/2016	Students were introduced to the digital storytelling process. They planned their digital stories on storyboards. They developed a story idea inspired by the museum content and drafted the script (e.g. chose a character, the point of view and develop a basic storyline of events).		+		+	+
Museum visit	Lesson 3: 1x90'-110' Museum and 1x60' School 01/11/2016	Students used their own mobile devices to take notes and photographs, and record sounds and videos. Materials were stored into Google Drive © folders set up for each group (see figure 3.4).		+	+	+	
Post-visit lesson	Lesson 4: 1x60' School 04/11/2016	Students wrote the scripts, audio-record them, and put the story materials (photographs, videos, music, audio narration	+	+		+	+

		and text) together using the video editing software of their choice. They edited and exported their digital stories.					
SQ: student questionnaires, NRL: notes in the reflection log, OF: observation forms, P: photographs, SO: student-generated outputs							

Table 3.2: The instruction and research designs in the first trial.

Students were assigned to work in groups of three, forming nine groups in total: Alabaster, Amaranth Purple, Amazonite, Atomic Tangerine, Aztec Gold, Battleship Gray, Bright Maroon, British Racing Green, and Burnt Umber.

The students had been asked to bring in their own smartphones and tablets and I guided them to download one of the following applications<sup>9</sup>: i-Movie<sup>10</sup> ©, Movie-Maker<sup>11</sup> ©, Splice Video Editor © for Apple<sup>12</sup>, Com-Phone Story Maker © for Android<sup>13</sup>.

The objective of using Google Drive © was twofold: 1. to store electronic copies of all the story materials produced on their own mobile devices during the museum visit to facilitate the content organisation; and 2. to assist students in sharing the content among group members.

<sup>9</sup> The applications were suggested after I reviewed and tested on my smartphone the applications recommended in the 'Educational uses of digital storytelling' website of the College of Education, University of Houston (US). Available at: <http://digitalstorytelling.coe.uh.edu/listpage2.cfm?id=22&cid=22&sublinkid=87> (accessed April 2015).

<sup>10</sup> <https://itunes.apple.com/gr/app/imovie/id377298193?l=el&mt=8> (accessed February 2016)

<sup>11</sup> <https://www.windows-movie-maker.org/> (accessed February 2016)

<sup>12</sup> <https://itunes.apple.com/us/app/splicevideoeditorfree/id409838725?mt=8> (accessed February 2016)

<sup>13</sup> <https://play.google.com/store/apps/details?id=ac.robinson.mediaphone&hl=en> (accessed February 2016)

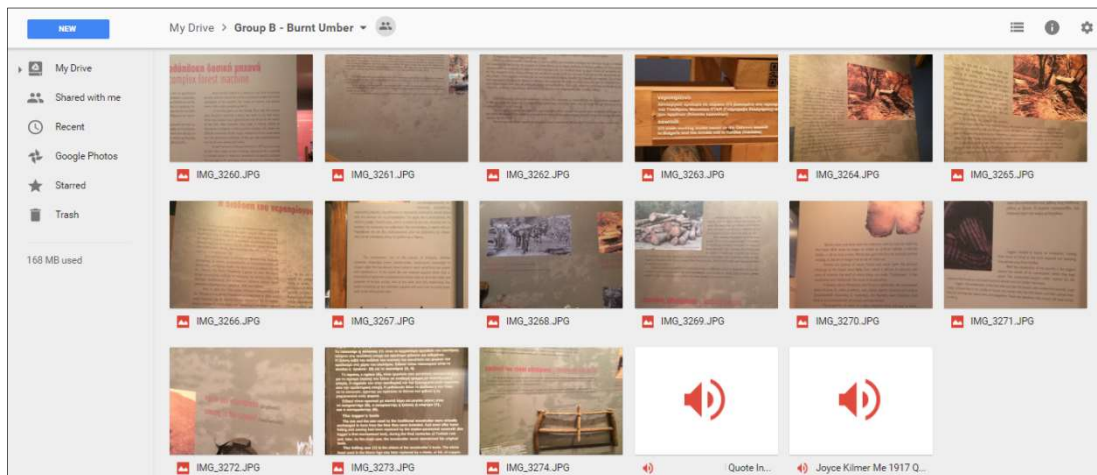


Figure 3.4: Print screen of the Burnt Umber group's story materials uploaded into their Google Drive © folder (accessed June 2017).

The instructional procedure was completed when they exported the digital stories by uploading them as video files to the Google Drive © folders or by sending them to me via email. There was no opportunity to watch the digital stories as a class and have students peer review (as the *DiStoMusInq* framework suggests) because the teacher could not provide more lesson time for the intervention. Nonetheless, I collected enough data about group work and sharing (sub-stage 3a) throughout the four lessons with my reflective notes, the student questionnaires, the photographs and the observation forms.

### 3.5.2 Second trial

The intervention in the second trial included a different ordering of lessons. Specifically, it included one (rather than two) pre-visit lesson that took place in the classroom, a two-hour museum visit with a follow-up session immediately after the students returned to school, and two (rather than one) post-visit lessons back in the classroom (see table 3.3).

	Lesson duration, setting and date	Lesson description (the instructional procedure)	In-lesson data collection tools (the data collection procedure)				
			SQ	NRL	OF	P	SO
Pre-visit lesson	Lesson 1: 1x60' School 28/03/2017	Students were given an outline of the inquiry-based learning process and they were introduced to the exhibition. They developed questions for and planned their museum investigations on the hand-outs.	+	+		+	+
	Lesson 2: 1x90'-110' Museum and 1x60' School 29/03/2017	Students used their own mobile devices to take notes and photographs, and record sounds or videos. Materials were stored into Google Drive © folders set up for each group.		+	+	+	
Post-visit lessons	Lesson 3: 1x60' School 03/04/2017	Students were introduced to the digital storytelling process. They planned their digital stories on storyboards. They developed a story idea based on the museum content and drafted the script (e.g. chose a character, the point of view and develop a basic storyline of events).		+		+	+
	Lesson 4: 1x60' School 04/04/2017	Students wrote the scripts, audio-record them, and put the story materials (photographs, videos, music, audio narration and text) together using the video editing software of their choice. They edited and exported their digital stories.	+	+		+	+
SQ: student questionnaires, NRL: notes in the reflection log, OF: observation forms, P: photographs, SO: student-generated outputs							

Table 3.3: The instruction and research designs in the second trial.

The students were put in groups of four (not in groups of 3 as in trial 1 to have an even distribution of members into each group) and five groups were formed: Alabama Crimson, Almond, Artichoke, Brass, and Burgundy. But after lesson 1 the Alabama Crimson group split into two sub-groups of two, forming six groups in total. The students from Alabama Crimson 1 said that they wanted to change their topic and they had developed different questions from Alabama Crimson 2. This was expected to have minimal impact on the data analysis performed based on my notes, the student questionnaires, the photographs, the student group interviews and the student-generated outputs because I could still use the responses to the individual questionnaires, take photographs and conduct a student interview for each sub-group separately. However, there was no observation form filled-in for Alabama Crimson 2 during the museum visit because of the number of chaperones on the trip. I could not arrange for another chaperone last minute. Thus, I did not have observation data about Alabama Crimson 2's investigative practices in the museum.

There was little time left and we managed to screen only two digital stories for peer reviewing (as the *DiStoMusIng* framework suggests). The discussion that followed was brief (eliciting general comments of preference) and the data not enough to justify for how they performed in this sub-stage (3b). Nonetheless, as in trial 1 I had enough data about group work and sharing (3a) throughout the four lessons from various sources.

### **3.5.3 Third trial**

The third trial included an online visit to the V&A via its digital collection. The intervention took place solely in the classroom and it included two pre-visit lessons, two lessons for the museum website visit and four post-visit lessons (see table 3.4).



	Lesson duration, setting and date	Lesson description (the instructional procedure)	In-lesson data collection tools (the data collection procedure)				
			SQ	NRL	OF	P	SO
Pre-visit lessons	Lesson 1: 1x60' School 24/05/2017	Students were given an outline of the inquiry-based learning process and they were introduced to the museum content. They developed questions for and planned their museum investigations on the hand-outs.	+	+		+	+
	Lesson 2: 1x60' School 25/05/2017	Students were introduced to the digital storytelling process. They planned their digital stories on storyboards. They developed a story idea inspired by the museum content and drafted the script (e.g. chose a character, the point of view and develop a basic storyline of events).		+		+	+
website museum visit	Lesson 3: 1x60' School 26/05/2017	Students used their own mobile devices and keywords to find, select and download information and photographs. Materials were stored into Google Drive © folders set up for each group.		+	+	+	
	Lesson 4: 1x60' School 29/05/2017	Students used their own mobile devices and keywords to find, select and download information and photographs. Materials were stored into Google Drive © folders set up for each group.		+	+	+	
Post-visit lessons	Lesson 5: 1x60' School 31/05/2017	Students wrote the scripts, audio-record them, and put the story materials (photographs, videos, music, audio narration and text) together using the video editing software of their choice.		+		+	

Lesson 6: 1x60' School 01/06/2017	They put the story materials (photographs, videos, music, audio narration and text) together using the video editing software of their choice.		+		+	
Lesson 7: 1x60' School 02/06/2017	They edited and exported their digital stories.		+			+
Lesson 8: 1x60' School 07/06/2017	Students watched the digital stories and engaged in a group discussion.	+	+			
SQ: student questionnaires, NRL: notes in the reflection log, OF: observation forms, P: photographs, SO: student-generated outputs						

Table 3.4: The instruction and research designs in the third trial.

The students were put in groups of three and eight groups were formed in total: Absolute Zero, Alloy Orange, Arylide Yellow, Azure, Beau Blue, Begonia, Bistre, and Bronze.

The teacher agreed to have eight lessons, which allowed students to have more time both for the data collection (2a) and the production (2b) sub-stages (a necessity the second trial findings revealed), and to have a screening of the digital stories as a class and a group discussion afterwards for reflection (3b). So, in lesson 8 the students watched their digital stories as a class and engaged in a group discussion to comment on both the outcomes and the learning process. I guided them into sharing opinions and feelings about the experience on the extent to which students answered their questions about the museum content by crafting a digital story.

### 3.6 Research design

As discussed in section 3.3, I used mixed methods for the data collection (Clark and Moss, 2001; Creswell, 2003; Creswell and Clark, 2011; Creswell et al.,

2003; Cohen et al., 2007; Hanson et al., 2005; Lodico et al., 2006; Winn, 2003).  
And my choices were guided by the research questions (see table 3.5).

<b>Data collection method</b>	<b>Timing of use</b>	<b>Type of data</b>	<b>What happens when we use digital storytelling to frame students' inquiry-based museum learning? What are the benefits for students' research skills development and what are the limitations as reported by both students and teachers?</b>	<b>What principles should guide the design of effective instructional interventions that use digital storytelling to frame museum investigations?</b>
Teacher pre-visit interview	Before start of intervention	Qualitative	Expectations of student learning outcomes and strengths and weaknesses pre-visit	Can digital storytelling and museum inquiry work well together? Suggestions
Student questionnaires	Before start and after end of intervention	Quantitative	Perceptions of competence levels of research skills development post-visit	Perceptions of most and least useful activities for museum investigation
Notes in the reflective log	After each lesson of each trial	Qualitative	What do behavioural patterns tell us about the overlap of the processes?	Challenges noted and how problems were solved by the students
Observation forms	During the museum inquiry	Semi-quantitative (behaviour tallies)	Research skills student activity indicated to be in action during the museum investigation	Strengths and weaknesses in behavioural patterns
Photographs	In lessons 2-4 (trial 1) In lessons 1-4 (trial 2) In lessons 1-6 (trial 3)	Semi-quantitative (coding counts)	Evidence of student activity and behavioural patterns in each lesson	Evidence of student activity and behavioural patterns in each lesson
Focus group discussion	After last lesson (trial 1)	Qualitative	Perceptions of overall learning experience and research skills development	Perceptions of what worked well and what did not
Student group interviews	After last lesson (trials 2 and 3)	Qualitative	Perceptions of overall learning experience and research skills development	Perceptions of what worked well and what did not

Student-generated outputs	Throughout the intervention	Qualitative (content) and quantitative (scores)	Evidence of learning outcomes and research skills development	Evidence of learning outcomes and research skills development
Teacher post-visit interview	After end of intervention	Qualitative	Perceptions of student learning outcomes and strengths and weaknesses post-visit	Did digital storytelling and museum inquiry work well together? Suggestions

Table 3.5: The data sources and their analytical purposes in the three trials.

Data collection sought to capture: 1. student activity (photographs, observation, reflective log) and performance (student-generated outputs); 2. students' perceptions of their experience (student group interviews, focus group discussion) and their research skills competence levels (student questionnaires); and 3. teacher views of the intervention (teacher interviews).

Next, I present and discuss how I chose, designed and used the data collection tools in all three trials.

### 3.6.1 Teacher interviews

Two teacher interviews were conducted to elicit the teachers' views of the interventions pre- and post-visit following a semi-structured interview protocol (see appendix XVIII). The questions were simple and short, seeking to elicit specific information and building on the teachers' answer to move forward. The style was conversational and informal.

The pre-intervention interview (06/10/2016) with the Art History teacher (trial 1) aimed to gain an understanding of her inquiry-based teaching practice and how she envisioned digital storytelling would frame the students' museum inquiries. She did not consent to recording the interview. Therefore, notes of her responses in verbatim were taken instead. And she was not willing to have a post-intervention interview due to her demanding schedule.

The post-intervention interview (25/06/2017) with the English Literature teacher (trial 3) aimed to get her perspective on how digital storytelling mapped onto the inquiry-based learning process and her suggestions for improving the framework. She consented to audio-recording and I used my smartphone to

do so. But I could not have a pre-intervention interview with her because the start of the intervention coincided with the preparation week for exams.

The ICT Literacy teacher (trial 2) was not available for interview neither prior nor after the intervention. So, instead of six teacher interviews I conducted only two, which was a significant change in my plans. However, both lasted for twenty minutes and provided me with some insights into teacher opinions. While interviews with all three teachers pre- and post-intervention would have shed more light on their perceptions of how the *DiStoMusInq* framework works, nevertheless, the information collected was valid and useful. I managed to elicit some information about teacher expectations of student learning outcomes, perceived students' strengths and weaknesses and some suggestions for an effective instructional intervention in the future.

### **3.6.2 Student questionnaires**

Two questionnaires were designed and administered to the students in each trial, seeking to collect information about the students' learning experience. No information about their life background was collected because it was irrelevant to the research objectives to profile the students based on literacy levels, personality traits or socio-economic status. The choice of participants required classes that had experience conducting inquiry work and students would explore the museum content in groups as part of an organised school visit. The questionnaires would help me understand how they made sense of this specific experience, gaining insights on perceived strengths and weaknesses. The pre-visit questionnaire was administered before the first lesson of each trial to enable collection of baseline data, while the post-visit questionnaire was administered at the end of the last lesson of each trial (see appendix XV). All students in all trials completed both questionnaires. The questions in both questionnaires were simple and the language was clear without technical terms. Methodological improvements between trials included minor changes made to question wording to adjust to the age of the students in each trial; and after the first trial, the splitting of one question into two (in order to differentiate between 'close looking' and 'note-taking').

The pre-visit questionnaire had two parts: the first part comprised two demographic questions (gender and age) and one attendance-taking question. The second part comprised twenty-two questions about students' levels of competence in research skills-associated activities such as making observations, forming questions and planning investigations (this part is discussed in more detail below). The post-visit questionnaire also included these two parts (with the addition of three attendance questions about the pre-visit, museum visit, and post-visit lessons in the first part and one question about what students thought of the use of mobile devices in the museum in the second part). It also included a third part that consisted of two open-ended opinion questions (Fraenkel et al., 2012) about levels of student satisfaction with the digital storytelling process.

The objective of the second part of the questionnaires was to gauge changes in their perceptions of research skills competence levels following the intervention. The measuring of research skills often relies on questionnaires where respondents self-assess their research performance (Harlen, 2013; Harrison, 2014; McMahon and Davies, 2003); objective measures of research skills were not readily available. Also, this study required a questionnaire that could be used across the three trials in order to enable comparisons; subject-specific objective measures would not satisfy this requirement. A series of questions representing subjective measures were therefore included, based on literature on inquiry skills, which asked students to indicate the degree to which they agreed or disagreed with a series of statements about inquiry-based learning activities using a 5-point Likert scale (Creswell, 2003).

Student self-assessments of research skills before and after an intervention reflect changes in how they *understand* their performance in relation to a research skill, without necessarily reflecting changes in performance itself. For example, a student who thinks of themselves as very good at synthesising information and rates themselves 4 out of 5 on it, may after an inquiry intervention realise that in fact their performance could have been a lot better and rate themselves lower. This does not necessarily reflect a decline in performance. Similarly, a student who previously rated themselves 2 out of 5 may after the intervention realise that, actually, they were quite good at synthesising information and give themselves a higher score. This is a direct

result of the nature of inquiry-based learning, which puts emphasis on the development of research skills and, consequently, makes the deployment of such skills more visible to students. For these reasons, the questionnaires were examined with reference to the rest of the data to understand how they made sense of the learning experience.

### **3.6.3 Notes in the reflection log**

After each lesson in each trial I took reflective field notes (Mauthner and Doucet, 2003). The objective was to keep notes of the students' activities and behaviour, comments about strengths and opportunities missed, as well as my perceptions of the interplay between digital storytelling and the inquiry-based learning process. In compliance with the guidelines for conducting research with children (Christensen and James, 2000) and the work of Yin (2011) on taking notes after fieldwork, I focused on students' actions and words. These notes, taken in my dual role as researcher-teacher of the intervention lessons, allowed me to identify similarities in what worked well among the groups and what challenges students faced. As explained in section 3.3, this study is exploratory and situates itself within a naturalistic inquiry context, following an interpretivist approach. My dual role and assumptions must have influenced the content of the field notes and the subsequent analysis, constituting it descriptive as well as interpretative. Nevertheless, the information was valid and useful, and I fed these reflexive observations into the analysis of the rest of the data (qualitative and quantitative).

### **3.6.4 Observation forms**

During the museum inquiries, I asked the chaperones to mark a tally on the observation form (see appendix VII) every time they observed the relevant activities within their assigned student group. The form listed nineteen statements with a tally column (c.f. McKechnie, 2000). The statements focused on counting instances of activities related to research skills in collecting and/or creating information for the digital stories, and instances of behaviour in terms of interactions with the museum objects, with each other and the mobile

devices. The statements were simple, and the language was clear without technical terms. The rationale behind this instance-counting approach was not to use the tallies as an objective measurement of student activity, but rather as a semi-quantifiable indicator for behavioural patterns. I used the forms as guides toward general qualitative analysis of each group's performance during data collection. I could thus paint a more detailed picture about strengths and weaknesses reported in the questionnaires, the photographs and field notes, identifying underlying reasons for the observed behaviour (Schwandt, 1998).

In the first trial in lesson 3 (01/11/2016), each of the four chaperones followed one group of students -45% of the class- to fill-in the form. There was no observation form filled-in for the other five groups because of the number of chaperones on the trip. In the second trial in lesson 2 (29/03/2017), each of the five chaperones followed one group of students -85% of the class-. There was no observation form filled-in for the sixth group because of the number of chaperones on the trip. In the third trial in lessons 3 and 4 (26/05/2017 and 29/05/2017), the teacher completed the form for each student group -representing 100% of the sample-. In the completed forms, tally number per activity statement per group ranged from 0 to 4 and, in the analysis, I assumed that three and four tallies showed a significant enough number of occurrences to indicate concentration of activity in the stages of the *DiStoMusInq* framework. This was taken to indicate high levels of group engagement with the related tasks because of more time spent and persistence.

### **3.6.5 Photographs**

For the majority of the lessons (13 out of 16) of the trials, I conducted photo-based observations with a digital camera -while trying to be as unobtrusive as possible albeit overt- to document the students' activities and movement in space. I decided to use photographic documentation influenced by the work of visual anthropologists (Collier and Collier, 1986; Harper, 1987), which showcased how photographs could be used to generate reliable data for analysis. Taking photographs helped me to capture time-stamped snapshots with details about the context of the setting and the students' interactions (Banks, 2001; Rose, 2007). The objective of taking photographs in the



classroom was to visually document students' work pre-visit, on-visit and post-visit, as well as during the web-based museum visit in trial 3, to compare behavioural patterns and interactions across the trials.

The pre-visit photographs depicted students planning their museum investigations (reading and writing on the hand-out and the storyboard) and discussing among themselves. The post-visit photographs depicted students analysing the information collected and/or created to synthesise the story materials and produce the digital stories. In the museums in trials 1 and 2, I shadowed one group at a time for approximately two minutes, which was enough to see what each group was doing, photo-documenting their work (I could not shadow all groups at all times). The photographs I took during the museum visits (onsite and online) depicted students engaged in investigative practices (taking photographs with their smartphones, reading the labels of the museum objects, taking notes, recording audio and/or video) and discussing among themselves. However, not all the photographs were useful for analysis. I chose the ones I could use as visual evidence of research skills in action based on the foreground and sharpness without paying attention to the background, symmetry or contrast. My criteria were the clarity of composition that shows intent and the perspective that exposed their task at hand.

<b>Lesson</b>	<b>Trial 1</b> (44 total; 37 analysed)	<b>Trial 2</b> (56 total; 48 analysed)	<b>Trial 3</b> (83 total; 72 analysed)
1	None	11	7
2	9	17	9
3	23	12	14
4	5	8	19
5	N/A	N/A	13
6	N/A	N/A	10
7	N/A	N/A	None
8	N/A	N/A	None

Table 3.6: The photographs taken during each lesson.

Table 3.6 above shows the number of photographs from each lesson that were analysed, as well as the total number of photographs taken and analysed per trial. I did not take any photographs in the first lesson of the first trial because I wanted to concentrate on laying out the intervention properly. This was not

an issue in subsequent trials because my experience from trial 1 enabled me to better manage my role as a teacher and a researcher at the same time. In trial 3 I did not take any photographs in lesson 7 because I expected students to engage in similar activities as in lessons 5 and 6. And I did not take any photographs in lesson 8 because I was monitoring the group discussion and I was unable to photo-document.

The photographs were stored in a password-protected personal computer to be analysed by coding. A list of tags, NVivo 11 Pro © nodes, was created (see appendix VI) to measure their frequencies on emerging and recurring codes and detect concentration or dispersion (Crabtree and Miller, 1999; Saldana, 2009; Strauss and Corbin, 1990; Wolcott, 1990). This tag list was used consistently in all three trials for the analysis of the photographs, the focus group discussion and the student group interviews.

### **3.6.6 Focus group discussion and student group interviews**

In the first trial, I held and facilitated a focus group discussion (07/11/2016) with representatives from the student groups (Merton et al., 1990; Morgan et al., 2002; Yin, 2011). Focus group discussions provide direct evidence about similarities and differences in the participants' opinions and experiences (Morgan 1997). The objective was to get at what students thought about the experience in a social context where they could hear 'the views of others and consider their own views accordingly' (Fraenkel et al., 2012: 457). Thus, the discussion was conducted in the classroom where students were able to talk about their experiences freely (Merton et al., 1956). I wanted to get students' perceptions of research skills development and their levels of satisfaction with the process by eliciting opinions and feelings about the effectiveness of the instructional procedure. It was not possible to perform the analysis per group because I could not extract useful information from all the group representatives about each question. Therefore, during the discussion I looked for emerging and commonly occurring themes as well as convergent opinions important for shedding light on the benefits and limitations of framing museum investigations around digital stories.

The sample was chosen based on three criteria: students had to have taken part in all the lessons of the trial, they had to have shown the lowest or the highest motivation levels, and they had to have completed the majority of the activities. The focus group discussion was conducted with eight representatives from the nine groups in the classroom and lasted for twenty minutes. The representative of the Amaranth Purple group did not attend the meeting on a last-minute notice, having minimal impact on the data collection procedure because I would not be able to juxtapose this group's opinion on the learning experience with the rest of the groups.

I developed a protocol (see appendix II) to provide the discussion with structure. The questions intended to cue the students to recall memories and to gradually elicit information related to their museum investigations and digital stories. Every student was given the opportunity to contribute her or his point of view. Even though it would be improbable to attain accurate recollections of every experience, the idea was to encourage them to describe and comment on their work to access information, which might not have been amenable to observation (how strands of thought are connected in the meaning-making process at the time of happening). The style was conversational and the register semi-formal. I audio-recorded the discussion on my smartphone, stored the file on a password-protected personal computer and prepared it for transcription and content analysis by coding.

In the second and third trials the focus group discussion was replaced by group interviews with the students (see appendix XIV), because I wanted to collect more, and more in-depth data on the extent to which students answered their questions about the museum content by crafting a digital story (something that the focus group did not allow me to do effectively). The group interviews would enable me to understand how groups managed self-directed learning, what opportunities they missed and if they believed digital stories were a good way to present answers to their group inquiries. Considering the fact that I could not observe students' thoughts and feelings during the activities, I held the group interviews 'to check the accuracy of -to verify or refute- the impressions [I] gained through observation (Fraenkel et al., 2012: 450). In the second trial, I conducted six group interviews (06/04/2017), which took place in the

classroom and lasted for ten minutes each. In the third trial, I conducted seven group interviews (07/06/2017) instead of eight because the Bronze group did not attend the meeting on a last-minute notice, which took place in the classroom and lasted for approximately ten minutes each.

The interview style was conversational and the register semi-formal. I refined the focus group discussion protocol and used it to provide the discussions with structure. The questions were simple, short and open-ended seeking to elicit information, building upon their answers to move forward. I tried to tolerate pauses and deal with inconsistencies in replies among group members by asking for clarifications without imposing assumptions about the intended meaning. The group interviews were conducted in the classroom to avoid disruptions. I audio-recorded the discussions with my smartphone, stored the files in a password-protected personal computer and prepared them for transcription and content analysis by coding.

### **3.6.7 Student-generated outputs**

I collected the student-generated outputs (hand-outs, storyboards and digital stories) after each trial as evidence of their learning process (Bartlett, 2015; Black et al., 2003; Wyatt-Smith and Cumming, 2009). The hand-outs and the storyboards were collected to guide me in understanding how each group planned their museum investigation and story. The objective was to use these alongside the scores of the digital stories to give me a complete picture of each group's learning experience and how each group made sense of it. The digital stories could have been considered artworks (Frayling, 1993) but analysing them as such to examine how students' artistic skills were exercised (e.g. in video composition or photograph manipulation) was beyond the scope of this study, which focused on their research skills. Therefore, the videos were assessed using the rubric I designed specifically to examine how good a digital story was as an output of inquiry-based museum learning (see appendix I).

To assess learning experiences through scoring, researchers designed rubrics with scales for differentiated achievement levels to scrutinise the video, and to assess to what extent students internalised content (McNeil and Robin, 2012; Ohler, 2013). The digital story's quality is a display of research work and

as such determines if it has the right elements and carries out an argument (depending on its dramatic question) (Alexander, 2011). This aligns with the principles of constructivism-based learning when assessment measures the extent to which internally mediated knowledge is situated in interactions with the environment and how students developed ownership for the task (Driver and Oldham, 1986). According to Jonassen (1999), the interpretation process requires activities that are imaginative and grounded in perception of physical experiences. In the context of this study, the quality is important because it is a representation of how students articulated their learning objectives (research questions), activities and decisions (data collection), and their answers. By measuring whether and to what extent their video fulfils certain criteria, I could gain an insight into how they engaged with the inquiry (and the museum content) and how they constructed their own interpretations.

To create this rubric, I drew on a rubric<sup>14</sup> designed for the judging in the Digital Storytelling Contests (2015) hosted by the North American University (US), the University of Houston (US) and the University of Texas (US). The objective was to embed the assessment of research skills within the assessment of a digital story, which I considered as an expression of learning (Dorn et al. 2004). The rubric included nine criteria classified under the first two *DiStoMusInq* stages (qualities related to the third stage, 'reflection', could not be assessed with this rubric, as the reflection stage takes place after the digital story has been produced). These criteria were: question setting, point of view, information seeking, script development and use of language, plot development and question answering, visual content, audio content, synthesis, and citing. Question setting had to do with how well the digital story laid out its purpose, with a clear point of view. Information seeking would show whether the digital story had a rich variety of visual and audio story materials, either original or gathered from quality sources, selected to serve the story purpose. Script development and use of language referred to the quality of the script that should be original with correct grammar, laying out the information. Plot

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<sup>14</sup> Digital storytelling contests evaluation rubric for official judging 2015 [online]. United States: North American University, University of Houston and University of Texas. Available at: <http://www.distco.org/wp-content/uploads/2015/10/Digital-Storytelling-Rubric-DISTCO.pdf> (accessed February 2015).

development and question answering had to do with how well the digital story presented the answers to the questions in a well-structured plot, otherwise complex with events or twists, having a beginning, a middle and end. Visual content referred to how photographs, videos or text, either original or gathered from quality sources, were used to convey the intended messages. Audio content referred to the audio narration of the script, which should be relevant and audible, and any sound and/or background music of good quality used. Synthesis had to do with how well the story materials were put together, making significant contribution to the story purpose. And citing was about the referencing of sources for the information used.

Four levels of descriptors were developed for each criterion, with corresponding scores of 4, 3, 2, or 1, reflecting the students' level of achievement in that criterion. An overall score was calculated by adding individual criteria scores and resulted in a split of groups into low-achieving, mid-achieving and high-achieving based on the scale: 9 to 20, 21 to 28, and 29 to 36, with 9 the minimum and 36 the maximum total score possible. The 27 available points were split into 3 with the low range spanning 11 points, the medium range spanning 9 and the high range spanning 7 points. The 21 mark is significant because in order to achieve this a digital story needs at least one 4 in one of the criteria and to get below 20 at least one 3 in one of the criteria.

### **3.7 The data analysis procedure**

#### **3.7.1 The data analysis rationale**

The different datasets were put together to be analysed per trial and per group (groups were my units of analysis) to get a complete picture of each group's learning experience in each trial. I aimed to understand how each group made sense of the intervention and performed overall. To do so, the responses to the individual questionnaires were put together per group and average group scores were calculated, which were analysed juxtaposed to the rest of the data (that were also organised per group). Analysing the data per group allowed me to compare expectations of student learning outcomes (depicted in each group's inquiry and story plans) to evidence of achievement (perceptions of

research skills competence levels, the self-reported most and least useful activities, the benefits and the challenges each group faced reported in the focus group discussion (in trial 1) and student group interviews (in trials 2 and 3)) alongside my notes, the photographs and observation forms (depicting behavioural patterns) to explore how digital storytelling worked side by side their museum inquiries. Having categorised student groups as low-achieving, mid-achieving or high-achieving based on their digital story's scores, I combined the diverse data sources to construct a narrative for each group on the basis of what happened in each lesson and how they made sense of it.

### **3.7.2 Data storage, management and tools**

Throughout the trials, I kept clear and accurate notes about data-logging in chronological order with appropriate references avoiding cut-outs and alterations (Streb, 2010). I organised the diverse datasets per trial and per group, allowing for themes to emerge from the data (Denzin and Lincoln, 2000; 2007; Sapsford and Jupp, 2006). Also, I remained consistent with the analysis layout to be able to use the records in future audits (Lincoln and Guba, 1985).

I maintained confidentiality and treated the data in accordance with the Data Protection Authority Guidelines in Greece<sup>15</sup>, the Data Protection Act 1998 in the United Kingdom<sup>16</sup> and as of 2018 the new General Data Protection Regulation<sup>17</sup>. All hard copy records were kept locked in a filing cabinet and all electronic copies were stored in a password-protected personal computer and backed-up into a hard drive with data encryption. The data was anonymised by removing direct identifiers and using pseudonyms instead. The records were archived to remain available for subsequent evaluation for seven years after the submission of the thesis and the publication of the findings, and then the records will be permanently destroyed and deleted. The provision for

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<sup>15</sup> Data Protection Authority Guidelines [online]. Greece: Law 2472/1997. Available at: [http://www.dpa.gr/pls/portal/docs/PAGE/APDPX/ENGLISH\\_INDEX/LEGAL%20FRAMEWORK/LAW%202472-97-NOV2013-EN.PDF](http://www.dpa.gr/pls/portal/docs/PAGE/APDPX/ENGLISH_INDEX/LEGAL%20FRAMEWORK/LAW%202472-97-NOV2013-EN.PDF) (accessed March 2016).

<sup>16</sup> Data Protection Act 1998 [online]. United Kingdom: Gov.uk. Available at: [https://www.legislation.gov.uk/ukpga/1998/29/pdfs/ukpga\\_19980029\\_en.pdf](https://www.legislation.gov.uk/ukpga/1998/29/pdfs/ukpga_19980029_en.pdf) (accessed March 2016).

<sup>17</sup> General Data Protection Regulation 2018 [online]. United Kingdom: Gov.uk. Available at: [https://ec.europa.eu/commission/priorities/justice-and-fundamental-rights/data-protection/2018-reform-eu-data-protection-rules\\_en](https://ec.europa.eu/commission/priorities/justice-and-fundamental-rights/data-protection/2018-reform-eu-data-protection-rules_en) (accessed March 2016).

disposal is to use a shredder for the hard copies and to overwrite and wipe the electronic copies stored in the magnetic media.

The criteria for the choice of data analysis tools were accessibility, ease of operation and affordability. The objective was to use tools that would present the data in a form that would assist in making interpretations per trial. I used the commercial packages of Windows 10 Home Edition ©, Microsoft Office ©, InqScribe © and NVivo 11 Pro ©.

### 3.8 Limitations

As no set of principles would ever work for all, at all times and contexts (Maxwell, 2011), this study has its limitations. I identified two types of biases: researcher-related biases and the design-related biases (see table 3.7).

Researcher-related biases	Design-related biases
Self-reported data influenced by my underlying assumptions about teaching, learning and research (e.g. selective memory, telescoping, attribution or exaggeration).	The limitations of the school and museum settings (e.g. accessibility, facilities, noise) and the biases of the participants (the Hawthorne effect, self-reported data, previous exposure).
The risk of rendering the research as less overt because of my leading role in the instructional and the data collection procedures.	Samples (sizes, age and gender).
	Time availability.
	The limitations of the data collection tools.
	The limitations of the data analysis tools.

Table 3.7: The biases.

Researcher-related biases might have jeopardised the validity of the study (Marshall and Rossman, 1995; Poggenpoel and Myburgh, 2003) as I had a dual role (that of the teacher and the researcher): to lead and monitor both the instructional and the data collection procedures. I had to undertake such a role in introducing the *DiStoMusInq* framework to the school. Even so, I allowed students control over the learning process and the outcomes (as the research objectives required), ‘encouraging more discovery-based or inquiry-led approaches to teaching, where the role of the teacher was to facilitate learning rather than to transmit knowledge’ (Hammersley, 1993: 427). As discussed in



section 3.3, the study is exploratory and situates itself within a naturalistic inquiry context, following an interpretivist approach. This meant that my dual role, the data collection and analysis methods and the data were reflexively interdependent and interconnected (Alvesson and Skoldberg, 2000).

I could not do much to minimise the limitations of the settings apart from ensuring that sites and resources were equally accessible to all and that conditions were conducive to learning. And little could be done to minimise the Hawthorne effect (Payne and Payne, 2004) or the threat of unreliable self-reported data, or to avoid the impact of previous exposure. The study partly lacked internal validity as this is inapplicable to this type of research (Fraenkel et al., 2012; Maxwell, 1996; Reiter, 2013). That is why I collected data from diverse sources, which would be triangulated (Zlatev, 2009). Even though data collection from diverse sources rarely produces comparable data because of incommensurable findings (Bloor, 1997), the trials were designed so that they would bring to the fore (mostly) subjective as well as objective perspectives.

### **3.9 Ethics**

Undertaking research outside the United Kingdom involved securing compliance with the Code of Practice for Research Ethics of the University of Leicester in the United Kingdom<sup>18</sup> and receiving clearance by the Ethics Committee. All participants (students, their parents or guardians and teachers) were given a project information sheet (see appendix XVI and appendix VIII), providing information necessary to make an informed decision about whether they wanted to take part in the study or not. They had two weeks to decide. It was clearly stated that no incentives or rewards of any kind would be offered. To ensure the integrity of the study (Drew et al., 2007), I obtained signed voluntary participation informed consent forms (see appendix XVII and appendix IX) from the students, their parents or guardians and the teachers.

The participants were children and exposing them to risk might have been oppressing or manipulating opinions, fraud or coercion, undue pressure

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<sup>18</sup> Code of Practice for Research Ethics [online]. United Kingdom: University of Leicester. Available at: <https://www2.le.ac.uk/institution/ethics/code/cop-researchethics.pdf> (accessed December 2014).

or revealing sensitive information, which relates to illegal, sexual or deviant behaviour. As a teacher with safeguarding certifications, I was alert to any signs of discomfort throughout the study. Also, a risk assessment for the museum visits in trials 1 and 2 (see appendix X) was signed. With respect to the students' intellectual property rights to their original work, it was stated in the project information sheet that students would keep the copyright and give me permission to use their work only for analysis and illustration purposes in writing the thesis and other associated academic documents. All museum content, including material available online, were treated as being the intellectual property of the museums. It was understood by all parties that no other non-educational use would be made without permission by the proprietors in a copyright release form.

### **3.10 Summary**

Chapter Three sought to present the research questions, the settings, the instruction and the research designs of this study (see table 3.8).

	Grade	Subject	Museum	Groups formed	Number of lessons	In-lesson data collection tools					Digital storytelling instruction	Mobile devices used	Out-of-lesson data collection tools
Trial I Oct-Nov 2016	8 (12-14 years old)	Art History	FEMMTH	9 groups of 3  26 students	4 2 pre-visit 14/10/2016	SQ	NRL	OF	P	SO	In lesson 2 (before the museum visit)	Smartphones and tablets	Teacher interview  Focus group discussion
					21/10/2016	+	+			+			
					1 museum visit		+		+	+			
					01/11/2016		+	+	+				
					1 post-visit 04/11/2016	+	+		+	+			
Trial II Mar-Apr 2017	6 (10-12 years old)	ICT Literacy	NOESIS	4 groups of 4 + 2 groups of 2  20 students	4 1 pre-visit 28/03/2017	SQ	NRL	OF	P	SO	In lesson 3 (after the museum visit)	Smartphones, tablets and laptops	Student group interviews
					1 museum visit	+	+		+	+			
					29/03/2017		+	+	+				
					2 post-visit 03/04/2017		+		+	+			
					04/04/2017	+	+		+	+			
Trial III May-Jun 2017	10 (15-17 years old)	English Literature	V&A (website)	8 groups of 3  24 students	8 2 pre-visit 24/05/2017	SQ	NRL	OF	P	SO	In lesson 2 (before the website visit)	Smartphones and laptops	Student group interviews  Teacher interview
					25/05/2017	+	+		+	+			
					2 online visit 26/05/2017		+	+	+				
					29/05/2017		+	+	+				
					4 post-visit 31/05/2017		+		+				
					01/06/2017		+		+				
					02/06/2017		+			+			
					07/06/2017	+	+						

Table 3.8: An overview of the three trials.

## Chapter Four

### Trial 1: Exploring the watermills of Macedonia-Thrace

#### 4.1 Introduction

The first trial took place in October-November 2016 at Pinewood school and included a class of 26 12-14 year-old students who visited the FEMMTH in the course of planning and undertaking group inquiries about the water-powered mills and agricultural life of the late-19<sup>th</sup> and early-20<sup>th</sup> centuries, as part of their Art History subject in the Greek ethnographic heritage unit. I conducted this trial to test the implementation of the *DiStoMusInq* framework in the classroom and explore how digital storytelling could frame students' museum inquiries in the context of an organised school visit with a series of four lessons. Students visited the exhibition *At the watermills of Macedonia and Thrace: gristmills, sawmills, fulling mills, cloth finishing waterfalls in traditional society* to collect information and craft a digital story that would present how they reached new understandings about their chosen topic (e.g. the sawmill, the fulling mill or the cloth finishing mill). The findings of the first trial point towards five emerging themes, which suggest that the digital storytelling process can blend well with the inquiry-based learning process in the *DiStoMusInq* framework and that it can frame mostly successful museum investigations. However, there are considerations to be made. These relate to the type of questions students set for their museum investigation, the importance of planning the story before the data collection, the fact that student behaviour in the museum appears to be uniform (in terms of activities -investigative practices- with a preference for video-recording), and the required flexibility to feed the collected information into their story plans.

This chapter presents the data obtained from the first trial and the analysis performed. Section 4.2.1 presents the findings from the pre-intervention teacher interview. Section 4.2.2 is a synthesis of the overall findings to discuss across groups and data sources how the students performed in each stage of the *DiStoMusInq* framework. A critical analysis of the emerging themes follows

in section 4.2.3. Section 4.3 discusses the improvements to the design of the intervention for the second trial.

## **4.2 Data presentation and analysis**

### **4.2.1 Pre-intervention teacher interview**

The first questions covered the teacher's inquiry-driven teaching practice in the Art History course. The teacher reported that implementing inquiry 'is a good idea because it encourages students to ask questions and promotes self-learning'. The teacher explained that research is one part of the process; creativity is another. 'Creativity guides them to ask questions, encourages them to do research work inspired by art to create new art'. This resonated with the constructivism-based approach to museum learning, which calls for self-initiated and self-directed learning (see section 1.2.1), and with the skills students develop when crafting a digital story (see section 2.2.2). In particular, the teacher explained that she asks each student to work independently on an investigation workbook throughout the course, based on an art-related theme (art movement or artist). The students look for, evaluate and select sources in a range of formats to find information about their theme and they write down why it is of interest to them.

The students have to come up with their own questions, find out the answers and more information about the work of art, document it properly and do their own creative work based on that.

She provides the students with prompting questions and resources for reading to help them develop a focus and determine what information they would need. This helps the students plan their investigations and is in alignment with the use of the hand-out in the *DiStoMusInq* intervention (see section 3.5). Then she asks the students to use drawing and/or collage to create their own work as a creative response. The teacher reported that

It usually works well. It develops a healthy sense of competitiveness. [...] Some are successful while others not, but overall personalised research inspires them.

However, the students were used to working individually and not in groups for the investigation workbooks. This discrepancy between students' prior exposure to individual inquiry-based learning with the requirements of the trial in terms of group work could be expected to have an impact on their performance in crafting a digital story as a group.

The assessment in this course had three components: the assessment of the investigation workbooks in terms of composition, quality and creativity, the assessment of homework in terms of independence and self-monitoring, and the assessment of class participation in terms of collaboration and initiative. The teacher reported that

It is not easy to assess. There is an assessment rubric which I use for the investigation workbooks, but it is mostly effort and participation that matter in this kind of work.

Furthermore, I elicited the teacher's opinion on whether digital storytelling could frame and facilitate inquiry-based learning in the museum, by assuming the form of the output of the inquiry work. She anticipated students to show high levels of motivation and be engaged in asking questions and looking for information as well as in crafting digital stories about the museum objects. 'I expect them to learn a new digital technology tool, a new way of investigating things and a different way of approaching art in the museum'. This suggested digital storytelling could structure museum investigations and frame inquiry-based learning.

Overall, the teacher interview suggested that the students would be able to conduct museum investigations and craft digital stories about the outcomes of their inquiries. They were expected to extend their inquiry-based learning knowledge applying it in the museum context learning at the same time how to create a digital story with the information they collected from the museum.

#### 4.2.2 Overall findings across groups and data sources

Based on the total scores of the digital stories (see figure 4.1), the mid-achieving and high-achieving groups were Alabaster, Amaranth Purple, Amazonite, Atomic Tangerine, Aztec Gold and British Racing Green; and the low-achieving groups were Battleship Gray, Bright Maroon and Burnt Umber.

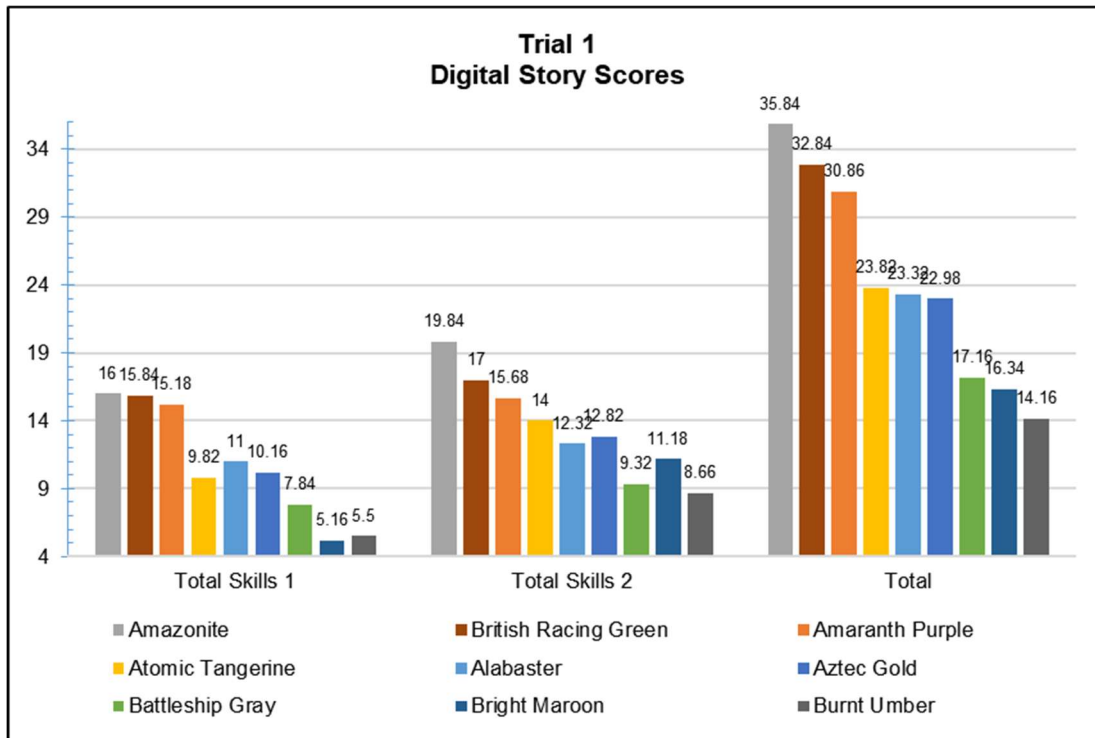


Figure 4.1: All the groups' digital story scores.

#### The high-achieving groups

Amazonite focused their inquiry work on the predecessors of the watermill. Their digital story was about the evolution of the mortar to the watermill and it scored very high. The way they specified their story needs in lesson 2 fed into the way they planned and conducted the museum investigation. Even though they depended heavily on video to illustrate their story, they produced a script that was supported by a well-structured plot and audio-recorded to accompany the visual content.

British Racing Green was another group that decided to work on the watermill. Their digital story scored very high. They planned and completed the museum investigation successfully. They contextualised the collected information into a plot that had a clear structure, integrating the answers to their questions in the words and actions of their character.

Amaranth Purple's digital story was also about the watermill and it fulfilled the criteria. They planned and completed the museum investigation successfully. But the planning of the digital story was not clearly specified before the commencement of the museum visit. That allowed them some flexibility after conducting the inquiry to think of how to contextualise the answers to their questions, synthesising the story materials in a well-structured plot.

### **The mid-achieving groups**

Atomic Tangerine focused their inquiry on the sawmill. They produced a digital story that partly fulfils the criteria but still communicates their approach to framing the museum investigation around a story. They had specific plans for the inquiry and the story and collected the story materials accordingly. However, they did not contextualise the evidential knowledge into their story structure. They prioritised audio-visual content over text and their plot has no connecting thread. In doing so, the questions were partly answered, and their digital story does not convey the intended message in a compelling way.

Alabaster decided to look into the cloth finishing mill. They crafted a digital story that partly fulfils the criteria but still shows how they made sense of their chosen topic. They planned and completed the museum investigation successfully. But their approach to digital storytelling, i.e. to depend on video and not produce an audio-narration that would accompany the photographs, impacted their performance in the second stage. They did not develop a plot (with a beginning, a middle and an end) with events that would integrate the answers to their questions within a story structure.



Aztec Gold's digital story was also about the fulling mill and it partly fulfilled the criteria. They had a story idea before commencing the museum investigation, but the story plan was basic (no script was drafted) and was not fed into their inquiry. They conducted the data collection successfully, produced a script but they used the power of the moving image to convey the intended message instead of developing a plot based on the historical information.

### **The low-achieving groups**

Battleship Gray worked on the watermill. Their digital story did not fulfil the criteria. It seemed that the inquiry process took over the digital storytelling process as they approached the museum investigation more like an exam-like inquiry assignment. If they had come up with a story idea, a character or a sequence of imaginative events, they could have used that as the base for a story structure.

Bright Maroon's digital story was about the watermill too, but it did not score high. They did not have a story idea that guided their inquiry work in the museum. They produced a video of factual information, which was not well-organised to tell the story of how the builder would have built the watermill; and, therefore, it did not fulfil the criteria.

Burnt Umber focused their inquiry on the sawmill. Their digital story did not fulfil the criteria. They planned and completed the museum investigation successfully. But they were not able to manipulate the information to tell a compelling story of what they learnt about their chosen topic. Had they developed a storyline or any events in the carpenter's life that would build up a plot and guide their subsequent data collection, their performance in the second stage might have been better.

The data about each group's performance revealed diverse learning experiences. The similarities and differences in each group's performance are drawn together across the data sources to find patterns that explain why for

the majority of the groups (six out of nine) the mapping worked well and why for others it did not.

In the first lesson, all the groups used the hand-out to develop questions that would guide their museum investigations and to determine what information they would need to collect. 'Students reported that the hand-out was useful, and they jumped right onto the task of forming their own questions'. They asked me questions such as 'What is inside the sawmill?', 'How does it work when it is snowy?' and 'Did women use other mills or just the cloth finishing waterfall?'. This showed that they wanted to envision what agricultural life was like at that time, suggesting that they were interested in the historical and social context and not just the museum objects. Nevertheless, the types of questions the majority of the groups formed were mostly focused on the physical features, construction properties and operation of the mills.

In lesson 2, the photographic data showed that the majority of the groups (except for two low-achieving) engaged in reading and writing text while using the storyboard (see table 4.1).

Group	L2 activities		
	RT	US	WT
Alabaster	+	+	+
Amaranth Purple	+	+	+
Amazonite	+	+	+
Atomic Tangerine	+	+	+
Aztec Gold	+	+	+
Battleship Gray	+	+	+
Bright Maroon		+	+
British Racing Green	+	+	+
Burnt Umber		+	
RT: reading text, US: using the storyboard, WT: writing text.			

Table 4.1: Photographic data tags in L2 for all groups.

All the groups used the storyboard to plan their digital story by deciding on the point-of-view with three groups (Alabaster, Amazonite and Atomic Tangerine)

adding information on the audio-visual effects they would like to add to enrich their story. The high-achieving groups though had also fictional characters developed, who would present through their words and actions the answers to the questions, and they drafted a script with a storyline that would guide their subsequent data collection in the museum (e.g. Amazonite). Low-achieving groups tended to have a basic storyline or a drafted script (e.g. Burnt Umber) but they did not develop a character, or their character was simply a means to communicate factual information. 'Some students complained that they could not draft the script without getting more information about the exhibition' and that 'too much writing was required on the storyboard'. This meant that, for these groups, the story could be fully developed only after they had collected the information they wanted, questioning the usability of the storyboard. It is worthy of further exploration whether the inquiry and the digital storytelling processes could have been sequenced differently (e.g. conceptualising the story after they had conceptualised the inquiry and conducted the museum investigation or given the opportunity to reconceptualise the inquiry once the story was conceptualised).

During the museum visit, all the groups used their smartphones and tablets to explore the museum content, collect and create story materials. I noticed 'students' excitement to collect information'. The observation findings showed that in three out of the four groups the most frequently observed activities corresponded to all the stages of the framework (see table 4.2).

<b>Stages with most frequently observed activities</b>	<b>Alabaster</b>	<b>Amaranth Purple</b>	<b>Amazonite</b>	<b>Battleship Gray</b>
1a conceptualization	+		+	
1b planning and managing	+	+	+	+
2a data collection and generation	+	+	+	
2b analysis and synthesis	+		+	
3a sharing	+	+	+	
3b peer review and reflection	+	+	+	

Table 4.2: The framework stages with the most frequently observed activities among groups.

For example, students showed increased engagement and they seem to have understood the purpose of the data collection, which related to the first stage of the framework. These findings agree with the literature about personalising the museum experience by eliciting story-based explorations (Hillman et al., 2015). As Trinkoff (2015) put it, museums connect better with students when they ‘begin to share their own personal stories, experiences, and meaning they form during visits’ (2015: 51). Students could locate resources easily and create information by taking notes and recording audio or video, using the mobile devices effectively, which related to the second stage. This confirmed previous studies reporting that mobile devices facilitated students’ efforts to collect information during the museum visit (Marty et al., 2013) and connect the visit with classroom learning (Vavoula et al., 2009). Also, students demonstrated good group work, which related to the third stage, and confirmed previous studies that showed the development of collaboration skills. Students ‘had to collaborate on how and when to take notes and negotiate the photographing, before venturing onto the story creation process’ (Nordmark and Milrad, 2015a: 369).

The photographic data showed that all nine groups had relatively uniform experiences in terms of interactions with the exhibits (see table 4.3).

Group	L3 activities								
	CL	RA	RT	RV	TE	TP	UH	US	WT
Alabaster	+		+	+		+		+	+
Amaranth Purple	+	+	+	+	+	+	+	+	+
Amazonite	+	+	+	+	+	+		+	+
Atomic Tangerine	+	+	+	+	+	+		+	+
Aztec Gold	+	+	+	+	+	+	+	+	+
Battleship Gray	+	+	+	+	+	+			
Bright Maroon	+		+	+		+		+	+
British Racing Green	+	+	+	+	+	+		+	+
Burnt Umber	+		+	+	+	+			+
CL: close looking, RA: recording audio, RT: reading text, RV: recording video, TE: touching the exhibit, TP: taking photographs, UH: using the hand-out, US: using the storyboard, WT: writing text.									

Table 4.3: Photographic data tags in L3 for all groups.

Students engaged in investigative practices such as close looking at the models of the water-powered machines ('to make the digital story we [...] had to pay attention to things we wouldn't have had normally' (Aztec Gold), 'we had to look at everything in detail because observing the objects, seeing all the actual mills over there helped us a lot with our investigation' (Bright Maroon)). The literature suggests that when students initiate investigations based on their interests, they 'gather information that specifically addresses their focused questions' (Maniotes and Kuhlthau, 2014: 10). The findings showed that they interacted with the objects ('we could see how they really worked because we saw the exact examples that were in the museum' (Battleship Gray)); they read the interpretative text on the panels ('we actually read the text instead of just guessing what it was for. We read almost all the labels in the museum' (Aztec Gold)), took photographs ('we took photographs of the things, we saw how they work and we read the things there' (Burnt Umber)) and notes on the storyboard ('students copied text from the labels' and 'they filmed themselves reading them'). Also, they recorded audio (apart from Alabaster, Bright Maroon and Burnt Umber) and video ('because we can record a video and take photographs and then put that all together and that worked right' (British Racing Green)).

The post-intervention questionnaire also asked students to identify the most and least useful digital storytelling activities for their museum investigations. Table 4.4 summarises per group responses, which reveal that across the nine groups the most useful activity was taking photographs (followed by close looking, note-taking and recording video) and the least useful activity was touching the exhibits.

Group	Most useful digital storytelling activity							Least useful digital storytelling activity						
	CL	TP	WT	RA	RV	TE	AG	CL	TP	WT	RA	RV	TE	AG
Alabaster		+	+		+									
Amaranth Purple		+											+	
Amazonite	+		+		+				+					
Atomic Tangerine	+	+	+		+		+			+			+	
Aztec Gold			+	+	+	+			+					
Battleship Gray	+	+	+			+				+	+		+	
Bright Maroon	+	+				+								
British Racing Green	+	+	+		+	+	+							
Burnt Umber	+	+			+	+	+				+			
CL: close looking, RA: recording audio, RV: recording video, TE: touching the exhibit, TP: taking photographs, AG: asking museum guide, WT: writing text.														

Table 4.4: Per-group analysis of the most and the least useful digital storytelling activities.

The findings were consistent with the photographic data because the mid-achieving and high-achieving groups were captured in at least one photograph engaged in the activities considered most useful. The groups that depended heavily on video though did not score as high in plot development and question answering (e.g. Atomic Tangerine). They seem to have assumed that recording video of themselves interacting with the model would be more useful than taking photographs because they would be able to better illustrate information. However, it appeared that using mostly video limited their creativity and choices to synthesise the information in a well-structured plot; possibly because video segments are not as easy to manipulate (and combine with an audio narration) as photographs are.

Furthermore, I noted during the museum visit that 'students were eager to try to move or operate the models themselves' (see figure 4.2).



(a)



(b)



(c)



(d)

Figure 4.2: Members of the Amaranth Purple (a), Amazonite (b), Battleship Gray (c) and British Racing Green (d) groups interacting with the models of the water-powered machines in the museum.

However, members of both mid-achieving and low-achieving groups reported that touching the exhibits was the least useful activity. This insight is not really aligned with the literature, which suggests that interaction on physical, emotional and intellectual levels leads visitors to an extended appreciation of its meanings (Wood and Latham, 2014). One explanation could be that hands-on material exploration was not necessary for the collection and/or creation of story materials because they did not have to touch the exhibits to find the answers to their questions. They could read the interpretative text on the panels and/or ask the museum guide questions. Even so, within the Battleship Gray group some students thought they benefited the most from interacting with the model while others the least. The fact that five (both low-achieving and high-achieving) out of the six groups thought this was one of the most useful activities meant that they perceived tactile engagement as supportive of their data collection. This is aligned with what the literature reports about

experiential self-initiated museum learning (Braund and Reiss, 2006; Holmes, 2011; Mcleod and Kilpatrick, 2001; Perry, 1992; Sorensen, 2003).

In lesson 4, students imported photographs, audio narrations and videos into the software and they arranged the sequence of the photographs, used transition effects, music and/or background sounds, and they exported the digital stories by uploading them as video files to the Google Drive © folders or by sending them to me via email. I noted 'students were excited about the prospect of showing what they had learned'. The photographic data showed that all nine groups engaged in synthesising the story materials and editing the digital stories on their smartphones and tablets (see figure 4.3).



(a)



(b)

Figure 4:3: The Alabaster, Amaranth Purple, Atomic Tangerine and Aztec Gold groups (a) and the Battleship Gray, Bright Maroon, British Racing Green and Burnt Umber groups (b) in L4.

The high-achieving groups presented the answers to the questions through a well-structured plot, which had a beginning, a series of events and an ending (e.g. Amazonite) and they enriched their story with an interpretation of the historical information that fictionalised the facts they learned in the museum (e.g. British Racing Green). They finalised the script after elaborating on the notes they had taken on the storyboard, which included information about the thoughts of the character weaved in the actions and events ('put all that together made sense' (British Racing Green)). They audio-recorded it on the smartphone, experimented with the transition effects offered by the software (I noted that in lesson 4 'it was common practice for students to experiment with the editing features'), and added music and/or parts of the script as a transition



effect onto some photographs (e.g. Amaranth Purple), which indicated that they explicitly wanted factual information to underlie the story. Whereas the digital stories of the mid-achieving groups did not fully answer the questions either because students depended heavily on videos that did not advance a plot (e.g. Aztec Gold) or because their plots lacked a connecting thread that would present in a compelling way how they embedded the historical information in their story. These findings showed that the inquiry process could include fictional elements, suggesting that the digital storytelling and the inquiry processes were at interplay. The interplay had to do with how the planning for the story guided the data collection during the museum visit and how the outcomes of their inquiry work were then fed into the story production in synthesising the historical information with fictional elements.

The low-achieving groups failed to develop plots that presented the answers to the questions through the words or actions of characters in a series of events. While they invariably found the answers to their inquiry questions during the museum visit, these answers were not presented successfully in the form of a digital story. Whether they prioritised visual content over text in their note taking (information for the script most likely came from video-recording themselves reading the panels), or they simply relayed the answer as they would in a standard test question (e.g. Burnt Umber), their plot development lacked sophistication. I noted that 'students found it challenging to determine the sequence of the photographs or to decide among photographs of the same content', 'they got frustrated over the limited time to edit' and 'they would like to work on personal computers instead of smartphones'. It is possible that these groups had all the necessary information but they could not organise ('for the video we had to like choose, we had to look at everything in detail' (Bright Maroon)) and synthesise it to tell a story with the answers. It is worthy of further exploration whether an in-class writing exercise on how to fictionalise using the historical information would yield different outcomes. Students would also benefit from better instruction on planning for both the inquiry and the story so that they are explicitly informed to develop not only a story idea or a character but also a storyline with events that would unfold the actions of their characters. And citing appeared to be a recurring issue with the majority of the

groups (eight out of nine), suggesting that better instruction (inform them clearly to provide credits, not just mention in the Power Point presentation the importance of referencing) should have been provided.

The averages of pre- and post-intervention student self-assessments of research skills (see figure 4.4) showed that, overall, there was at least marginal improvement in their perceptions for all research skills competence levels with the most improvement observed in conceptualising inquiry work.

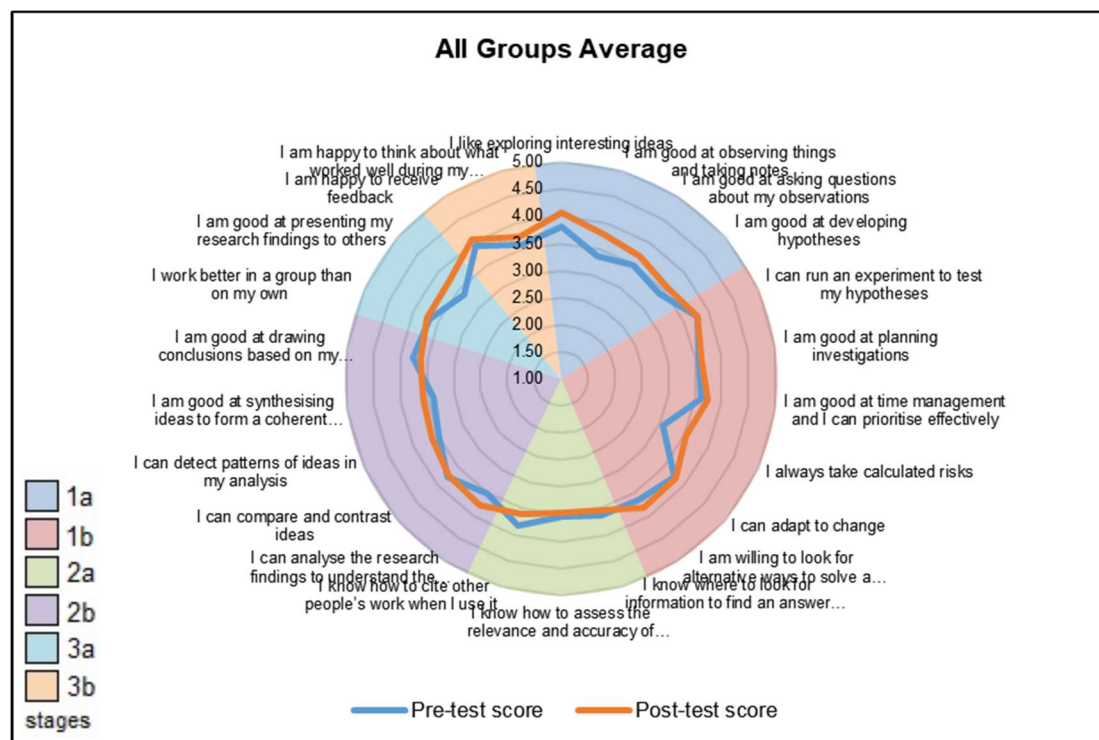


Figure 4.4: The averages of pre- and post-intervention student self-assessments of research skills.

Both high-achieving and low-achieving group representatives (seven out of nine) agreed that having to craft the digital story helped them conduct the museum investigations. These findings confirmed previous studies reporting that the crafting process scaffolds the development of higher-order thinking skills, including research skills (Alismail, 2015; Abdel-Hack and Helwas, 2014; Czarnecki, 2009a; Czarnecki, 2009b; Ganley and Vila, 2006; Gregori-Signes, 2008a; Gregori-Signes, 2008b; Hathorn, 2005; Hung et al., 2012; Kearney, 2009; Robin, 2006; Teehan, 2006; Yuksel et al., 2011). As the teacher had

anticipated, they benefited from being exposed to a new way of investigating and approaching the museum content. Despite the fact that three groups faced issues with manipulating the collected information to turn it into a story, students were generally able to apply prior knowledge of the inquiry process to conduct the museum investigations and the majority of the groups managed to craft a digital story that presented the answers to the questions they had set. As Amazonite put it 'the research, I mean finding the information, was a good process and making the story laid it out for us. And I think that it did help us understand more about the subject in general'. This suggested to me that digital storytelling did have merits as a frame for museum inquiries, and I should persist with figuring out the specifics of the lessons in order to maximise the benefits for the students.

#### **4.2.3 A critical analysis of the emerging themes**

There are five themes emerging from the overall findings of the nine groups' learning experiences that show synergies between the inquiry-based and the digital storytelling learning processes. These are: 1. The type of research questions influenced the data collection; 2. The importance of story planning prior to the data collection; 3. The uniformity of the students' interactions during the data collection; 4. The required flexibility with story planning after the data collection; and 5. The preference for video over an audio narration.

Below, I present each theme with a detailed description of a group's performance and I discuss how the new knowledge relates to existing knowledge in the literature.

##### **The type of research questions influenced the data collection**

It seems that the research questions each group set in lesson 1 had an impact on their efforts to collect information and develop a plot with a connecting thread that would present the answers in a compelling way.

I use British Racing Green's learning experience as an example. Their digital story told the story of the miller whose job was to process the wheat and produce the flour. The miller was neither the owner of the watermill nor of the produce; thus, he was paid a fee based on the kilos of flour he could produce every day. British Racing Green used factual information to build a fictional character, representative of the miller at that time. In lesson 1 they used the hand-out to develop two research questions: 'What do we know about the life of the miller in the agricultural society of the late-19<sup>th</sup> century?' and 'What can the watermill's physical features tell us about its use?'. The first question is quite different from questions previous groups had set for their museum investigations because it is an open-ended type of question that probes into the social context of the watermill. Its connection to the second question is the miller and the role a real or imaginative character can play in presenting evidential knowledge about the machine's use and operation.

In the second lesson they used the storyboard to draft their script -without including information on audio-visual effects-. They chose to use the first-person point-of-view and they decided that the emotional intent would be to entice feelings of achievement and pride in knowing how to use the watermill.

During the museum visit British Racing Green explored the museum content to find answers to their questions. They were captured in at least one photograph engaged in close looking, taking photographs and touching the model, reading the interpretative text on the panels, taking notes, recording audio and recording video (see figure 4.5). For British Racing Green, the most useful activities were observing how the model was operated in action, taking photographs and recording videos of themselves interacting with it.



(a)



(b)



(c)

Figure 4.5: British Racing Green members (a) working on the storyboard and writing their script in lesson 2, (b) searching the museum collection for suitable material in lesson 3, and (c) producing their digital story in lesson 4.

In lesson 4 they finalised the script after elaborating on the notes on the storyboard (see figure 4.6) and audio-recorded it on the smartphone.

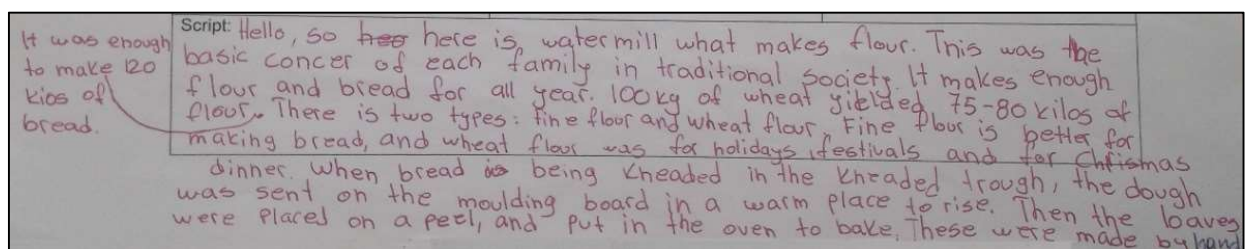


Figure 4.6: Part of the British Racing Green group's drafted script.

For example, they wrote:

The water is channelled down a gradient through a wooden canal called a trough and strikes the waterwheel with force causing it to turn up to

one hundred revolutions per minute. The shaft of the waterwheel transmits the revolution to the upper stone via a metal fitting called swallowtail. Then what I have to do is guide the grain that falls from the hopper into the space between the top and the bottom stone where it is grinded. My job is done when I collect the flour in the tub. I rub the flour between my fingers to test it and I wait until the whole grist has been ground. It feels nice and it smells like raw fresh bread. Each day I grind up to 1500 kilograms of wheat. My fee amounts to 3 up to 12 per cent of the grist on the good days. But I don't do it for the money. I like making flour because it is the basis of everything. Flour and water that is. What troubles me though is the rats and that is why I keep cats around. And there is nothing I can do about flies and ants.

This extract showcases that they were able to mix facts with fiction and present how they visualised the life of the miller would look like. The plot they developed had a beginning, a middle and an end, which matched the tasks completed by the miller in a day's work (i.e. how and why each task in the flour production was followed by the next). Through the voice of their character they presented the answers to their questions and had historical information in how they imagined the miller's profession to be like. This performance was reflected in the high total score their digital story achieved, i.e. 32,84 (see figure 4.7), which they produced using the Splice © software on the smartphone.

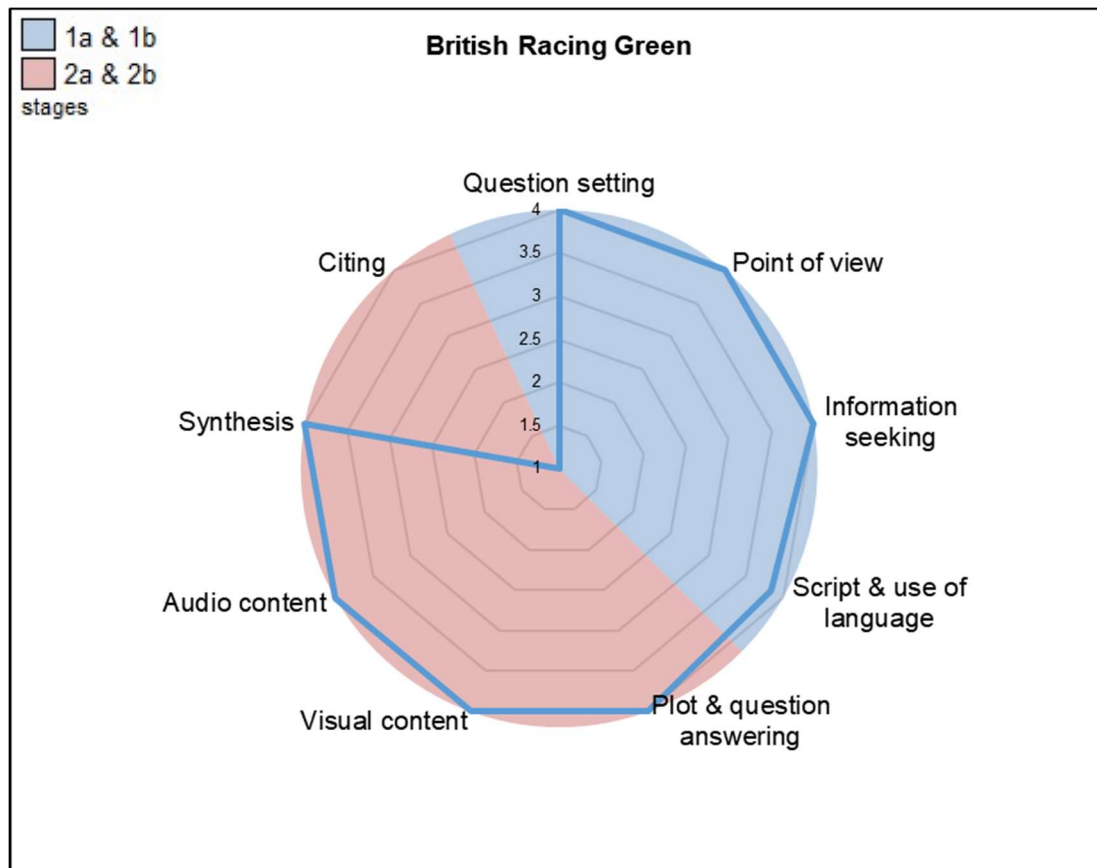


Figure 4.7: The British Racing Green group's digital story score.

Their performance suggests that the open-ended type of research questions students set in lesson 1 allowed them to be flexible in their data collection. This agrees with the literature reporting that inquiry-based museum learning should involve less structured meaning-making efforts, which welcome open-ended discoveries and experimentation. As Kuhn (2005) put it, 'for inquiry to be meaningful, students must believe there is something to find out, distinguishable from what they already know' (2005: 84).

### **The importance of story planning prior to the data collection**

It is understood that the groups that developed -at least partly- a character and a sequence of events in lesson 2 did better after the data collection in writing scripts and in adjusting these to develop well-structured plots. In other words, having a basic story idea to guide their data collection was helpful.

I use the learning experience of Aztec Gold to illustrate this. Aztec Gold used a series of photographs and videos of themselves interacting with the fulling mill to tell the story of its construction based on a fictional character, the builder of the machine, who had an accident while building it. In lesson 1 they used the hand-out to discuss amongst themselves which questions they would like to pursue, and they came up with two research questions about the object's construction and function. These were 'How was the fulling mill constructed?' and 'What can the object tell us about the function of the machine?'.

In the second lesson they used the storyboard to plan their digital story, but they did not draft a script. They decided on the point-of-view they would use, i.e. the first-person, and on the emotional intent of their digital story, which was to intrigue and excite the viewers to find out more about the fulling mill. They came up with the idea about the tragic event but other than that they did not develop the character or the storyline further, for example they did not think of the events before or after the accident, of any descriptions of the life of the character or any details that would help them contextualise the facts about the fulling mill into their plot.

During the museum visit they used their smartphones to engage in material exploration and they were captured in at least one photograph engaged in close looking at the model and touching it, taking photographs, recording audio and video while it was in operation, reading and note-taking on both the hand-out and the storyboard (see figure 4.9). The questionnaires showed that they found note-taking, recording object sounds and video as well as touching the exhibit as the most useful activities; whereas taking photographs was the least useful activity. Their digital story achieved a high score in visual content with a total score of 22,98, which placed Aztec Gold among the mid-achieving groups (see figure 4.8).



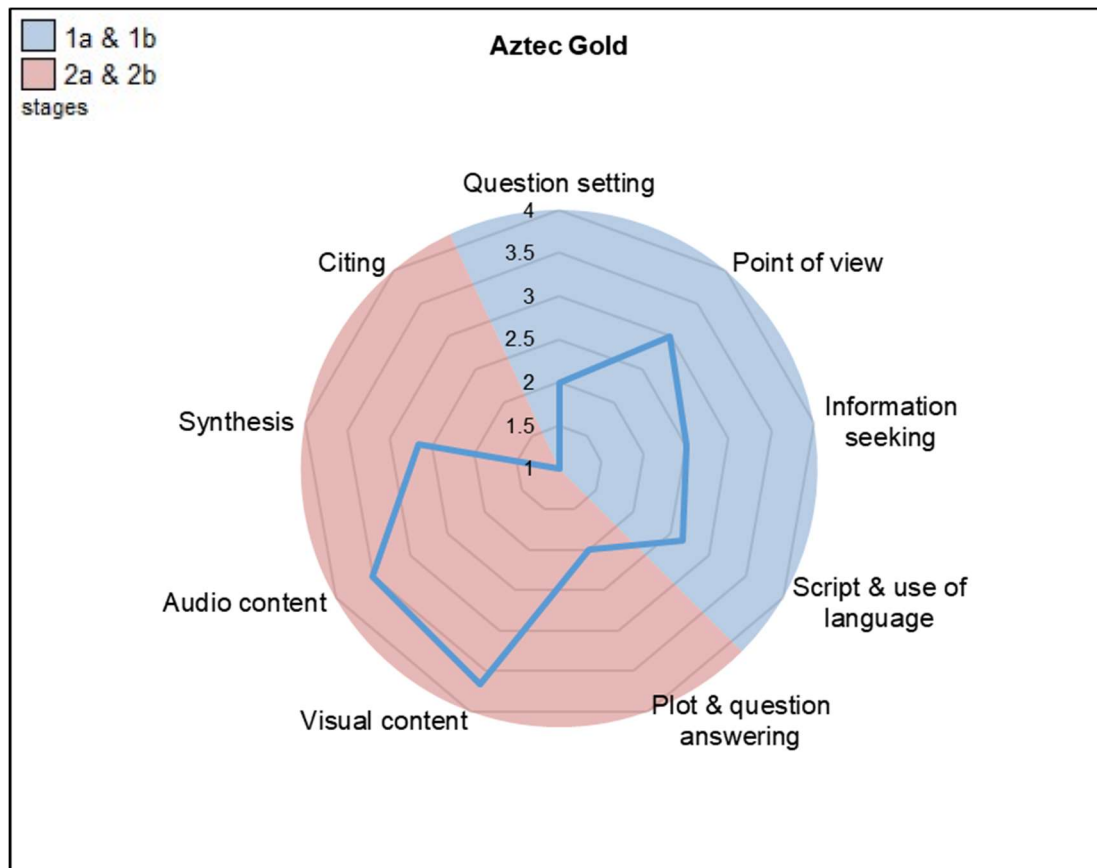


Figure 4.8: The Aztec Gold group's digital story score.

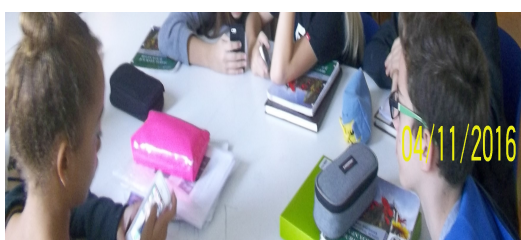
Like previous groups, they seem to have assumed that recording video of themselves interacting with the model would be more useful than photographs because they would be able to better illustrate how the fulling mill was designed and demonstrate how it worked.



(a)



(b)



(c)

Figure 4.9: Aztec Gold members (a) working on the storyboard and writing their script in lesson 2, (b) searching the museum collection for suitable material in lesson 3, and (c) producing their digital story in lesson 4.

In lesson 4 they worked on drafting and writing the script, which they audio-recorded on the smartphone. They wrote:

The hammer crashed my hand. I lost the floor under my feet. I could not move. I was the only one who knew how these were used so I had to save myself. I had cut each piece of wood, placed it carefully next to the other and tied the mechanism in one. It was very complex. I had to hurry because water is falling through a wooden channel that turns the waterwheel and the camshaft converts the rotary movement into the reciprocal movement of the stocks. The cloth is pounded by the hammers as they repeatedly drop. I built the hammers in such a way that they move steadily not to damage the fabric. Weaving is an art going back to the Stone Age. It allowed humans to progress from wearing animal skins and plant leaves to processed clothes. Friction and beating increases the durability of the cloth and makes it warmer.

This extract shows how they blended historical information with fiction. The tragic event served as the hook to start the story. But apart from that, the plot

was poor because no other events or information on the character's life were weaved in the story (for example, what were the implications of the accident on the character's life). Their digital story scored high in script development and the use of language (as the script somehow answers the questions) but low in plot development and question answering because they failed to develop a well-structured plot (with a beginning, a middle and an end). This could be because they were more focused on the language (how to talk about the accident) than on how to integrate the information in a series of events that would build up the plot. This might have been avoided if they had drafted the script in lesson 2. In hindsight, the Aztec Gold representative said that 'I'll probably like to have more time in the museum. [...] Not to rush it'. However, collecting more information would not necessarily help them turn it into a story; therefore, the group appears to not have correctly identified their weaknesses which primarily were in plot development.

Next, the group imported the story materials into the i-Movie © software to produce the digital story on the smartphone. They edited the story materials and managed to export the video on time. Even though they found the needed information and they performed well in editing, they did not craft a story that presented the answers to the questions through the words or actions of characters in a series of events. Indeed, their inquiry was successful (they found the answers to their questions), but the plot failed to reflect the depth of their inquiry, meaning that in lesson 2 more emphasis should have been given on the importance of planning their stories.

This insight confirms what the literature says about the importance of planning before the commencement of the data collection. In fact, research has showed that setting a story idea and storyboarding are important steps in the planning stage (Ohler, 2006; Smeda et al., 2010). Thus, conceptualising a story that would present the answers to a museum inquiry is not a different case.

### **The uniformity of the students' interactions during the data collection**

The interactions students had with the museum objects and with each other during the data collection appear to be uniform, but each group directed their own learning. Even though most of the groups engaged in similar activities, each group was free to navigate in the exhibition space and collect story materials the way they wished. The fact that all groups were successful in conducting their museum inquiries aligns with what the literature reports about self-directed inquiry work (Calder, 2015; Maniotes and Kuhlthau, 2014). Simply put, students should be given control to explore the museum content following their own interpretative pathways.

Battleship Gray is an interesting example to investigate. In lesson 1 they used the hand-out to develop two research questions about the watermill. These were 'What are the physical features of the watermill?' and 'What is its function?'. But their digital story had no characters beyond the narrator, who briefly presented the properties and function of the watermill.

In lesson 2 they did not draft the script; they made notes such as 'we will be exploring the watermill like detectives'. They noted that their digital story would be informative, but they did not have a storyline planned or any characters developed or information about the audio-visual effects. Most likely, they spent the lesson time discussing about their story and not actually planning for it filling-in the storyboard.

During the museum visit the students used their smartphones to conduct the museum investigation and find the answers to their questions. The observation data showed that they managed their time well, they were able to locate and collect information, but they performed poorly in creating story materials and keeping records of the sources they used (see figure 4.10).

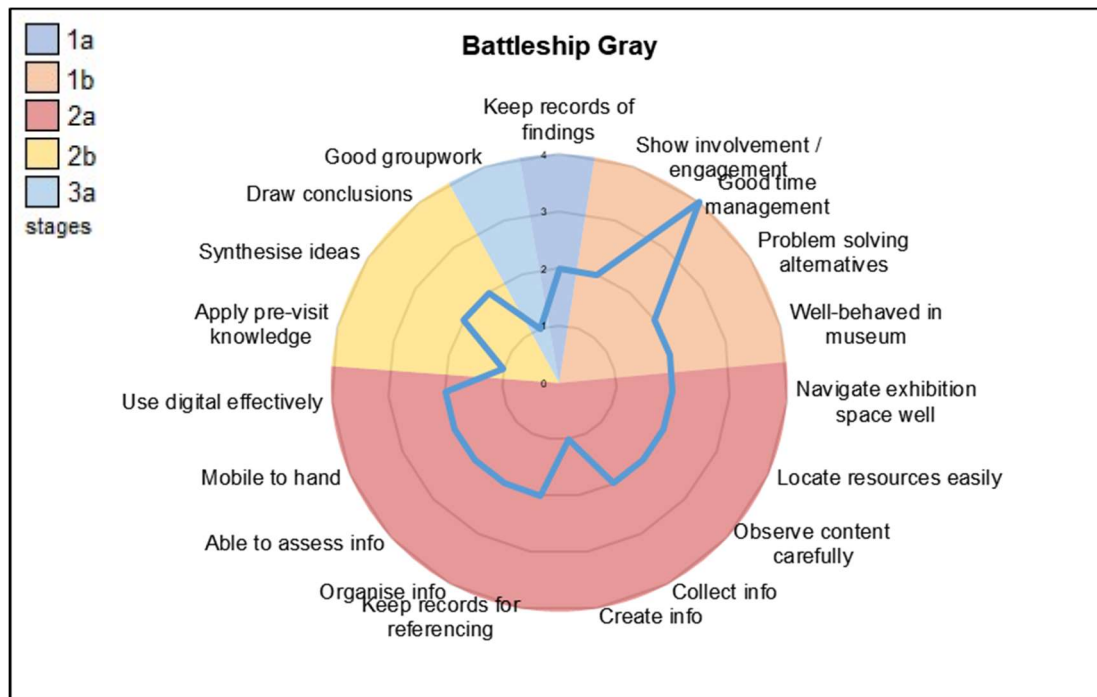


Figure 4.10: The Battleship Gray group's observation data.

They were seen in at least one photograph engaged in close looking at the watermill, taking photographs, recording audio and video of themselves interacting with it and reading the interpretative text on the panels (see figure 4.12). In the questionnaires they reported that observing the object closely, touching it and taking photographs were the most useful activities. As one student commented 'we saw how it worked, how it felt and that helped a lot'.

But they were not seen note-taking. Battleship Gray was the only group that the photographic data did show them engaged in writing during the museum visit. Perhaps I did not capture them doing so but their storyboard did not have notes other than the ones taken in lesson 2. This performance was reflected in the low score their digital story got, i.e. 17,16 (see figure 4.11).

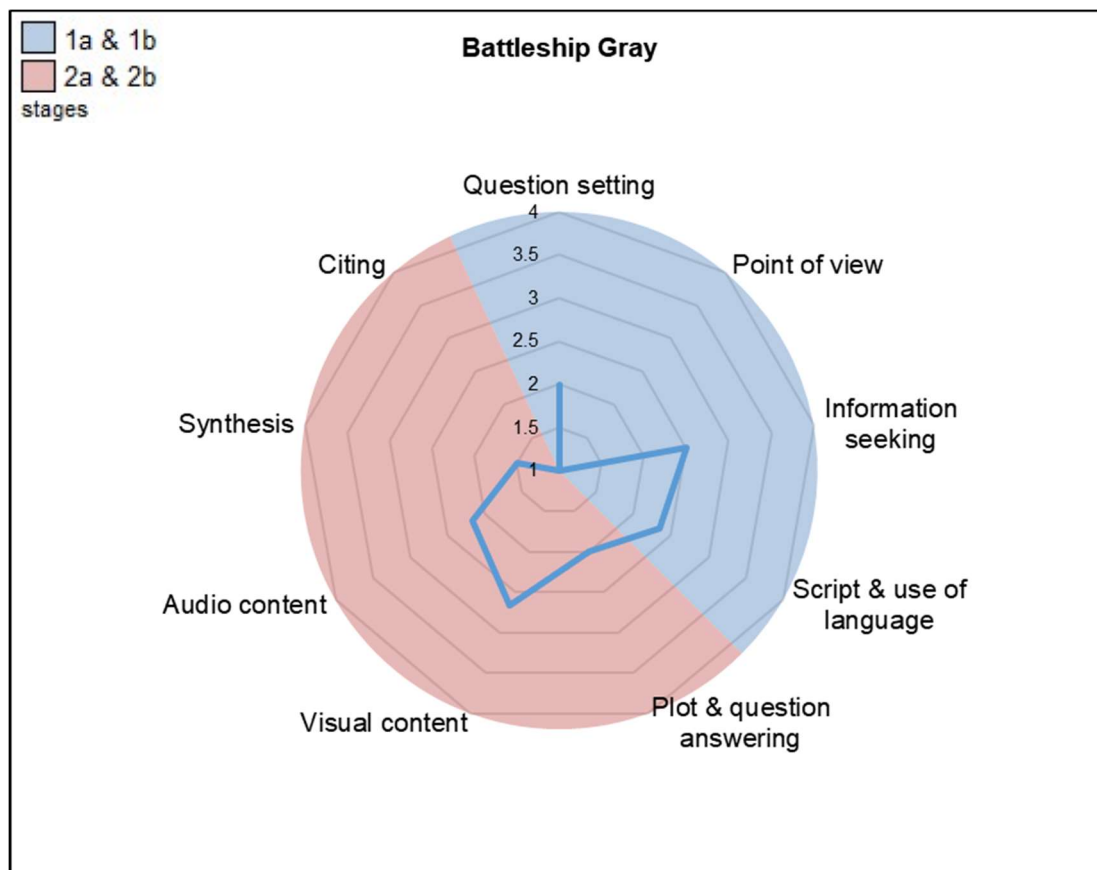


Figure 4.11: The Battleship Gray group's digital story score.

With respect to data collection, it got moderate scores whereas it scored low in question setting, plot development and question answering, synthesis of story materials and citing. This could be the result of not having developed a storyline or a character; or not having taken notes of relevant information for the script while exploring the museum content. One student commented in the questionnaires that 'taking notes was not that useful for our investigation because we took photographs and videos'. This suggested that, for Battleship Gray, collecting visual content was a substitute for taking notes. However, their decision not to draft the story and use the storyboard to plan for their story had an impact on their data collection and on how the digital story was produced.



(a)



(b)



(c)

Figure 4.12: Battleship Gray members (a) working on the storyboard and writing their script in lesson 2, (b) searching the museum collection for suitable material in lesson 3, and (c) producing their digital story in lesson 4.

In lesson 4 they used their smartphones to go through the collected information and craft the digital story. To do so, they used the Splice © software. They wrote a brief script and audio-recorded it on the smartphone. Since they had not taken notes, they watched the videos they had collected several times in order to develop the script. They wrote:

The watermill is an old water and metallic machine that people used to grind the wheat to make flour. It consists of a driving mechanism with a waterwheel, a spindle and its pinion, the hopper and a grinding mechanism. The grinding mechanism has two horizontal stones that rotate and crash the wheat, the shut diverts the water coming from the waterwheel, the hoist regulates the distance between the stones and the crane grasps the top stone whenever needed.

This text shows poor performance in fictionalising the information they collected in the museum. The information most likely came from video-recording themselves reading the panels. Other than having a narrator explaining what the watermill looks like and how it works, there is no indication





photographs and recording video). Even though students are free to manage their inquiry on their own, such uniformity calls to question their willingness to do something different or deviate from these investigative practices. Nonetheless, even within an organised school visit, students can 'choose what to observe, how to interpret the information, and consequently conclude the most personally relevant and important messages' (Banz, 2008: 50).

### **The required flexibility with story planning after the data collection**

Another emerging theme is the required flexibility with the story plans after having done the data collection. It seems that high-achieving groups adjusted their story plans to the results of their inquiries and developed a plot with a connecting thread, blending somehow facts with fiction.

For example, Amazonite were successful in doing so. Their story was about the evolution of the mortar to the watermill. They used a series of photographs and videos to explain how the first watermill was built. Based on a female character, an unidentified woman, they presented the answers to the questions through a well-structured plot, which had a beginning, a series of events (how each hand mill was designed, used and contributed to the advancement of the mills), and an ending with the woman reflecting on her life and drawing similarities and differences between the predecessors to the watermill. They chose to create a character whose life would serve as a retrospective lens to look back in time and understand how the first watermill was constructed. In lesson 1 they used the hand-out to come up with two research questions. These were 'How was the first watermill built?' and 'What can the objects tell us about its evolution?'.

In lesson 2 they used the storyboard to develop a draft of the woman's life. The point-of-view they chose was the third-person and the emotional intent was to entice the viewers' curiosity and interest in the advancements of agricultural technology. They drafted the script and decided on the audio-visual effects such as the frames and angles they would like their photographs to have to create a visual effect like eye-level angles (for the viewer to feel like

she is actually looking at the mill being used) and close-ups (to magnify and concentrate on details). They were specific with planning the digital story and this fed into their planning of the inquiry because they would look for specific data to build up a storyline with events that would point the contribution of each mill to the watermill development.

During the museum visit they were highly engaged in exploring the museum content and creating story materials using the tablet and their smartphones (see figure 4.14).

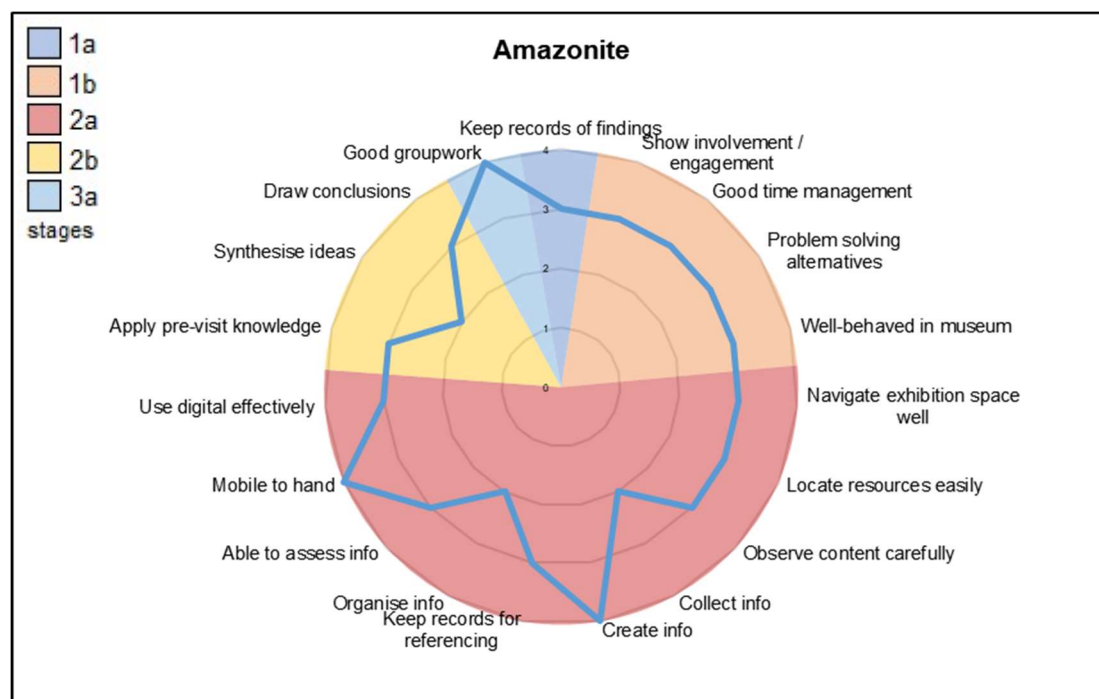


Figure 4.14: The Amazonite group's observation data.

Amazonite was captured at least in one photograph observing the model carefully, interacting with it, reading the interpretative text on the panels, taking photographs and notes on the storyboard, recording audio and video (see figure 4.15).



(a)



(b)



(c)

Figure 4.15: Amazonite members (a) working on the storyboard and writing their script in lesson 2, (b) searching the museum collection for suitable material in lesson 3, and (c) producing their digital story in lesson 4.

They devoted most of lesson 4 to the development of the script by writing and rewriting it. To do so, they consulted their notes (see figure 4.16) and reviewed the videos they had collected.

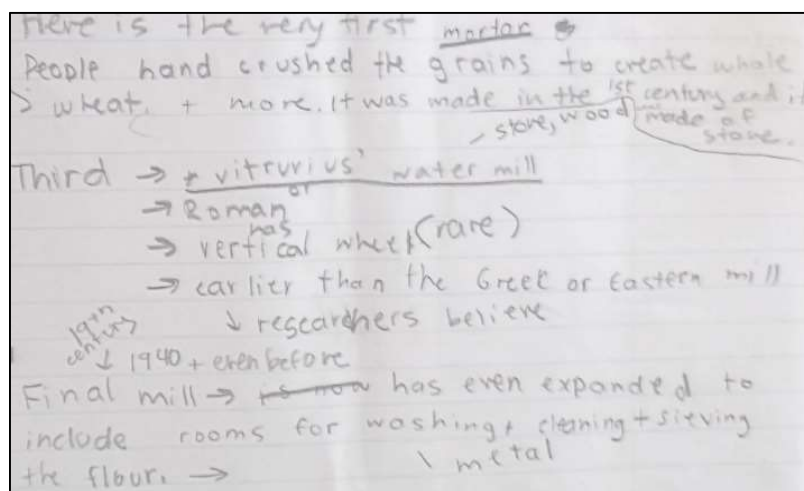


Figure 4.16: Part of the Amazonite group's redrafted script.

They wrote:

Let me show you what I've learned all these years in the fields. This was and will always be my life. Here is the very first mortar. People hand-crashed the grains to create whole wheat. It was made in the 1<sup>st</sup> century and it was made of stone. Here we see the second hand-mill. I wasn't getting as tired anymore. As you can see we placed the grains in the centre of this machine and turned the handle in a circular motion to crash the grains and create whole wheat. It was made of stone and wood. [...] Over the years people saw that water can be useful for agricultural work. The hand mill evolved into a watermill. The only difference is that now the mill runs on water. The first watermill was thought to be in the palace of Mithridates VI in the 1<sup>st</sup> century BC. They used to call it *hydraleta*. It took me time to learn how to use this, but we were happy it was automated and faster. It was created in the 19<sup>th</sup> century and slowly expanded to include parts for cleaning and seeding the grains. It was made of metal and wood.

This text shows that they added historical information into the fictional events in the woman's life. In alignment with the literature review findings, the findings show that differences in the story plans result in changes to the ways the production is done (Robin, 2008). They synthesized facts such as construction materials and dates logically. Their character's role was to take the viewer on a journey back in time and show them how each machine gave way to the next. They finalised their script, audio-recorded it on the smartphone and put the story materials into the i-Movie © software to edit the digital story using the tablet. They worked on the audio-visual effects as planned. For example, they included an instrumental song as background music, which they cited, and used close-ups of photographs they had taken (see figure 4.17).

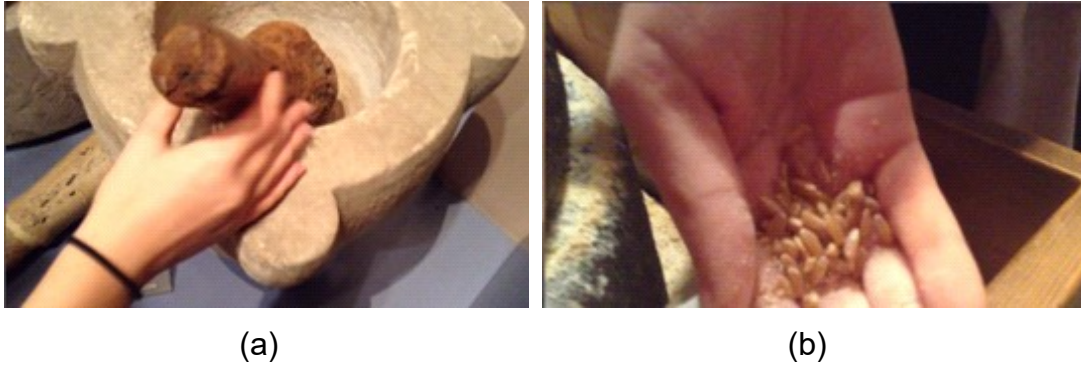


Figure 4.17: Screenshot (a) from the Amazonite group's digital story shows a group member using the *goudi* (mortar), and screenshot (b) shows a group member using the handheld grinder for making flour.

Their digital story achieved an almost perfect score of 35,84 (see figure 4.18) because it had a well-structured plot, which provided the answers to their questions, and it included cited sources.

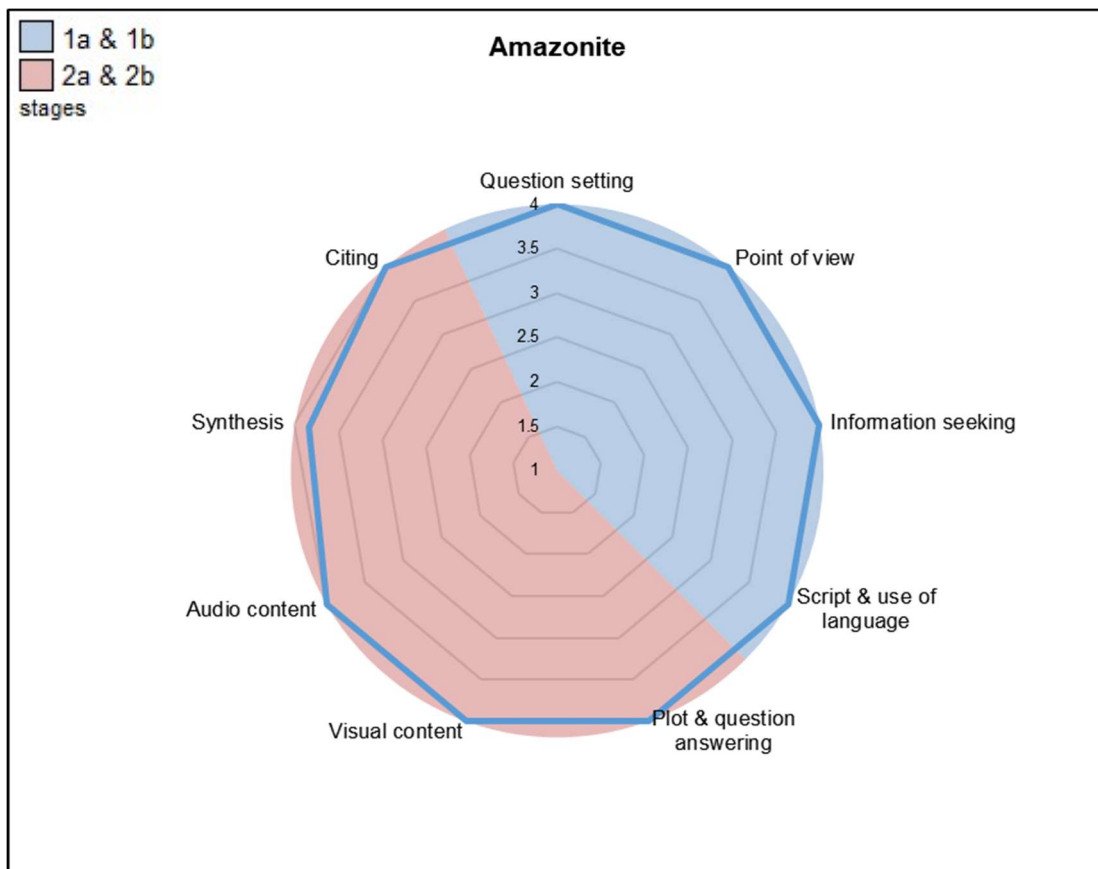


Figure 4.18: The Amazonite group's digital story score.

Their learning experience shows how a digital story can present the results of a museum inquiry when students employ their imagination to create fictional elements that weave historical information into the story, and when they are willing to experiment with ideas along the synthesis stage. As in previous studies, students had to 'organize, analyse, and construct explanations using the data they collected' (Cahill et al., 2011: 22). This insight thus agrees with Ohler (2007) and Miller (2010), who stated that producing a digital story involves re-writing the script and making informed decisions about the editing.

### **The preference for video over an audio narration**

In many cases, students preferred video over an audio-recorded script, which compromised the plot development. Students invested in the power of the moving image instead of working on their script and integrating the answers to their questions within a story structure.

Alabaster presents a case like that. They wanted to use factual information about the construction and function of this machine and through the voice and actions of their fictional character, an unidentified man, to explain how the mill was designed and operated. In lesson 1 they used the hand-out to conceptualise the museum investigation and they developed two research questions 'How was the cloth finishing mill designed and which are its physical features?' and 'How was the mill used?'. They used a series of photographs and videos of themselves interacting with the model mill to portray through the character's actions how it was designed, built and used.

In the second lesson they used the storyboard to plan their digital story, whose intent was to entice the viewers' curiosity and interest in how the mill works. Alabaster chose the third-person point-of-view in their narrative and drafted the script, which included information on audio-visual effects such as the music they would like to add to enrich their story (see figure 4.19). For example, they drafted in the script:

The workday in the cloth finishing mill was long and exhausting. It took much effort to get wool ready for weaving the clothes, especially the winter clothes, and each part had to be ready before the next begins.

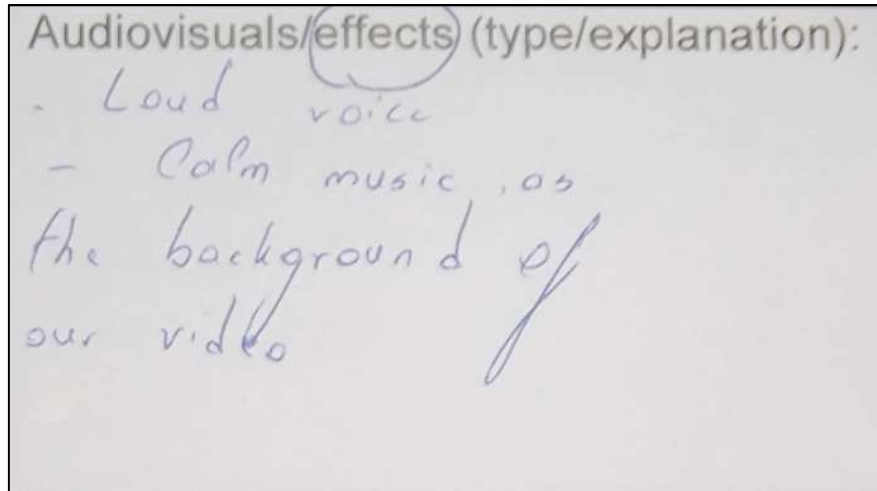


Figure 4.19: Part of the Alabaster group's drafted script.

They made a note that they would like to add 'calm music' to this part to show the time-consuming and laborious efforts of their character. After I had shown the class general information about the museum content, including photographs of the models exhibited (see section 3.5.1), Alabaster seem to have interpreted wool production as a long, tiring and step-by-step process. This indicated that, for Alabaster, the inquiry process could include fictional elements such as an imaginative character's actions with an interpretation of how it felt to operate the mill. This suggested that the digital storytelling and the inquiry processes were at interplay as the character's feelings at each stage were scripted once that stage had been researched and interpreted.

During the museum visit the group were observed using the smartphones to explore the museum content and create story materials, locating and assessing the relevance of information, reading the interpretative text on the panels, taking photographs and notes, recording videos and keeping records for references (see figure 4.20).

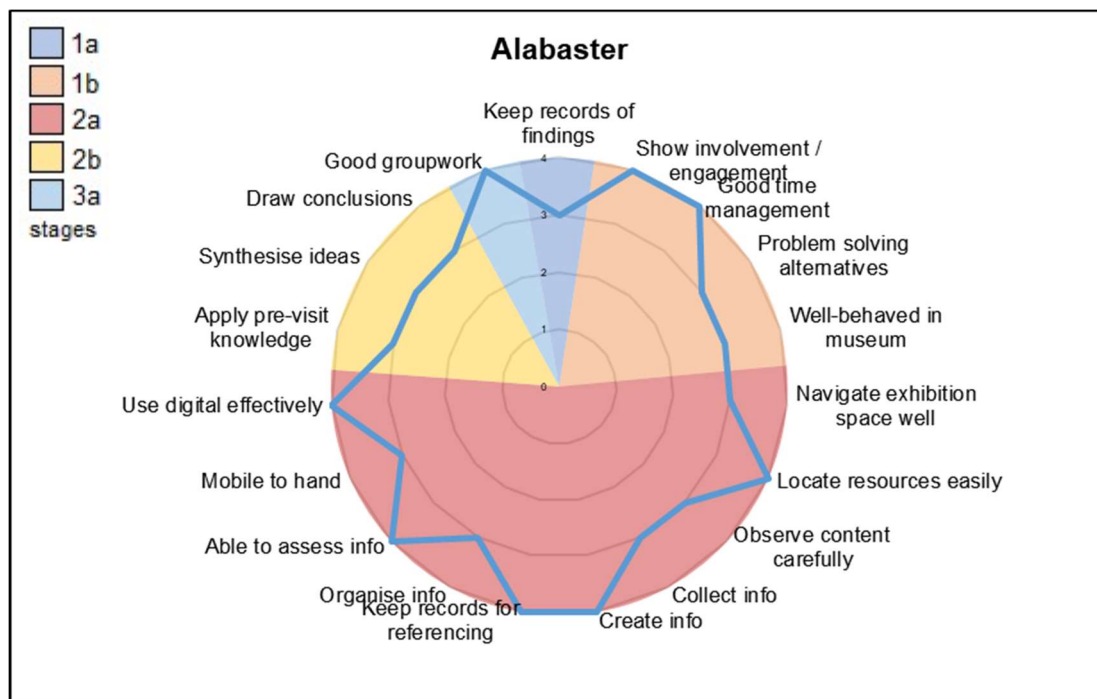


Figure 4.20: The Alabaster group's observation data.

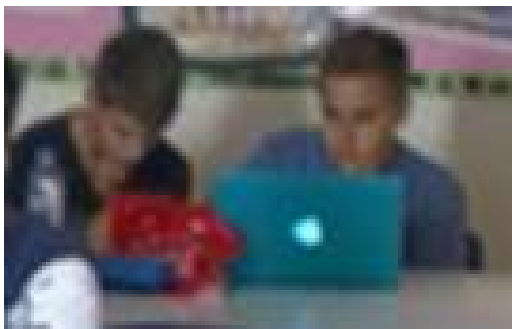




(a)



(b)



(c)

Figure 4.21: Alabaster members (a) working on the storyboard and writing their scrip in lesson 2, (b) searching the museum collection for suitable material in lesson 3, and (c) producing their digital story in lesson 4.

In lesson 4 they imported the photographs, the videos and the music into the i-Movie © software to produce the story on their tablet (see figure 4.21). They finalised the script but instead of recording it as an audio narration on the smartphone they decided that one member would embody the character himself. They video-recorded him reading the script, and the video was edited and cut in parts so that it would be inserted in between the photographs. The story starts with the character presenting the mill's features but what follows is a sequence of unconnected short videos that partly demonstrate how the mill was operated. The student says in the video:

The shape of the tub causes the water falling into it to whirl and as the textiles in the water are tossed and turned and rubbed together, the fibres in the yarn swell, shrink and soften.

Then the corresponding photographs appear (e.g. see figure 4.22).



Figure 4.22: Screenshot from the Alabaster group's digital story.

Their decision to not audio-record the script but use video instead indicated a preference for visual content over audio content. This performance was reflected in the high scores their digital story scored in information seeking and visual content, achieving a total score of 23,32 and placing Alabaster among the mid-achieving groups (see figure 4.23).

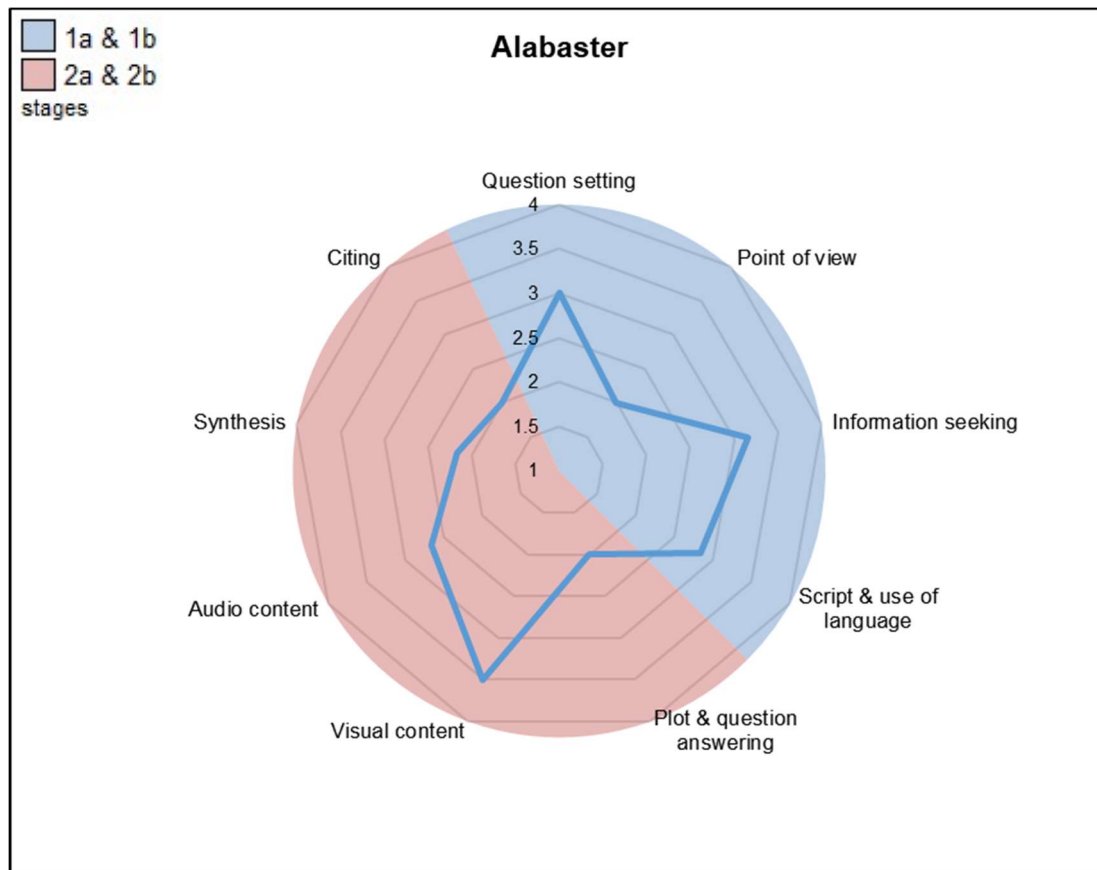


Figure 4.23: The Alabaster group's digital story score.

But this deviation from the instructions impacted the score their digital story achieved in audio content, plot development and question answering as well as in synthesis because these videos were not put together logically. In their story there is no step-by-step explanation of the design and construction process of the mill. Their choice of presenting the answers to the questions, i.e. mostly through videos, was straightforward but they did not really fictionalise the facts in a story. What is more, the story ends abruptly failing to communicate fully the intended message.

This meant that the inquiry process took over the digital storytelling process as they concentrated more on visually representing the answers rather than using the collected information to craft a story about the answers. They had visualised how their character's actions would contribute to showing why and how the mill was used for, but they depended heavily on video to present the answers. In the analysis and synthesis of the story materials, they did not contextualise the character's actions within a well-structured plot that would

allow them to blend facts with fiction and present their newly acquired knowledge in a compelling way.

This could be explained by the visual nature of the digital story. According to Lambert (2006) and Robin (2008), a digital story communicates a message visually, using multimedia. This insight points towards a preference for video not only for enticing the imagination of the viewer but also for (re)presenting factual information and demonstrating facts. This suggests that students need better scaffolding in finding the balance between using the moving image and contextualising the information within a story structure.

#### **4.3 Improving the intervention**

After performing the data analysis, I decided to change the order of the lessons and have the museum visit *before* the introduction of the digital storytelling process. This would allow me to explore whether bringing the digital storytelling in after the museum visit would have a positive impact on how well the outcomes of the museum investigation are presented through a story. This decision was based not only on the fact that several student groups in the first trial had problems in doing this, but also the fact that the students themselves asked for more information about the exhibition while drafting the scripts, indicating that they might be better placed to conceptualise a story after having completed the inquiry work in the museum. With respect to the use of personal computers, in trial 2 the chosen course was ICT Literacy and they would use the classroom laptops as well as their smartphones and tablets.

#### **4.4 Summary**

The objectives of the first trial were to try out the instructional and the data collection procedures and explore possible answers to the research questions by analysing the first set of data for the study. The findings presented here were encouraging, in that they indicated that the digital storytelling process can frame mostly successful museum investigations.

## Chapter Five

### Trial 2: Understanding ancient Greek technology

#### 5.1 Introduction

The second trial took place in March-April 2017 at Pinewood school and included a class of 20 10-12 years-old students who visited NOESIS in the course of planning and undertaking inquiries related to ancient science and technology as part of their Information and Communication Technologies Literacy subject. I conducted the second trial, which included a different ordering of the four lessons, to gain more insights into how the mapping of the two processes might work in a reversed sequence as the findings of trial 1 suggested. In this trial the museum visit was scheduled before the students were introduced to the digital storytelling process. As such, they conducted their museum investigations without having a story in mind. This sequence of the lessons allowed me to explore another way of how the digital storytelling process could be mapped onto the inquiry process. Students visited the exhibition *IDEA - Ancient Greek Science and Technology* to find answers to their group inquiries based on their chosen topic (e.g. astronomy, architecture or naval technology) about technology in ancient Greece. The findings of the second trial show the existence of four similar themes, underpinning the mapping of digital storytelling onto the inquiry-based learning process, which did not work as well as in trial 1. The main insight is that the type of questions students set for their museum inquiries had an impact on their data collection and it later posed difficulties in turning the information into a story, most likely because they did not have the story in mind while collecting materials. Also, it appears that some groups could not find enough relevant information in the museum and this led them to resort to their imagination to fill-in any gaps in their plots. Finally, it was clear (as in trial 1) that student behaviour in the museum presented uniformity. These insights suggested I change the instruction design back to way the first trial was run in order to gain a better understanding of how the digital storytelling process overlaps with the inquiry-based learning process in the *DiStoMusInq* framework.

This chapter presents the data obtained from the second trial and the analysis performed. Section 5.2.1 is a synthesis of the overall findings to discuss across groups and data sources how the students performed in each stage of the *DiStoMusInq* framework. Section 5.2.2 presents a critical analysis of the emerging themes. Section 5.3 discusses the methodological changes to the design of the intervention for the third trial.

## 5.2 Data presentation and analysis

### 5.2.1 Overall findings across groups and data sources

Based on the total scores of the digital stories (see figure 5.1), the mid-achieving and high-achieving groups were Alabama Crimson 1, Alabama Crimson 2 and Artichoke; and the low-achieving groups were Almond, Brass and Burgundy.

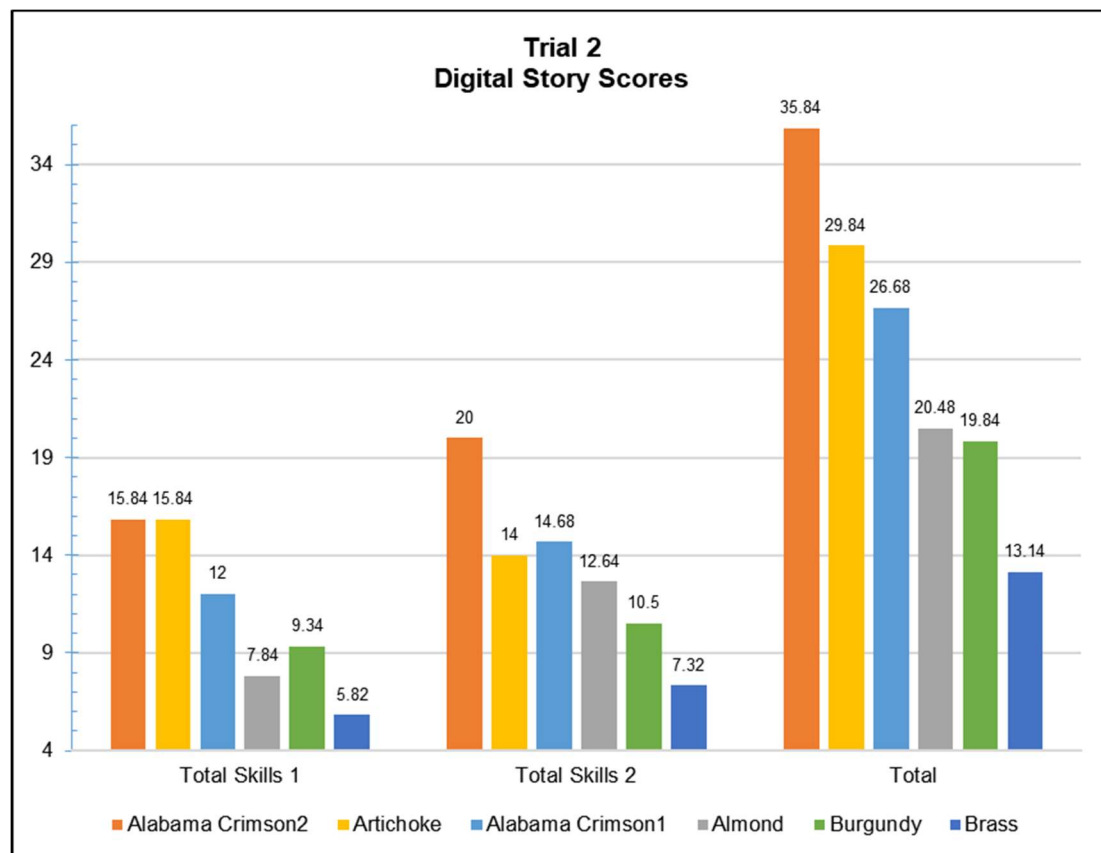


Figure 5.1: All the groups' digital story scores.

### **The high-achieving groups**

Alabama Crimson 2 decided to work on naval technology and the trireme. Their digital story fulfilled the criteria. The questions they had set were focused on the trireme's properties and use but they were also open-ended. This might be why the data collection overwhelmed them but at the same time it allowed them some flexibility to collect more information. With the information they had collected, they built up a storyline with a well-structured plot that presented the answers to their questions through the words of the two oarsmen.

Artichoke's digital story was about the Antikythera mechanism and it fulfilled the criteria. They planned and completed the museum investigation successfully, showing a preference to taking photographs and notes. Even though they found the data collection a bit challenging (because they could not find all the information they wanted to), in the story production they used their imagination to fill-in the gaps in facts with fictional elements. In a way they made sense of the museum content through their story.

### **The mid-achieving group**

Alabama Crimson 1 focused their inquiry on the catapult. Their digital story partly fulfilled the criteria. They planned and completed the museum investigation successfully. However, their approach to digital storytelling was to depend heavily on video for illustrative purposes and not produce an audio narration of the script. This had an impact on the quality of their digital story because it lacked a plot with a clear structure.

### **The low-achieving groups**

Almond decided to conduct a museum investigation about the catapult. Their digital story did not fulfil the criteria. They planned and completed the data collection successfully, but their digital story lacked an audio narration and the audio recordings of themselves reading from the panels were brief and not

organised in a way that serves the story's purpose. It seemed that Almond faced a difficulty in turning the collected information into a story.

Burgundy decided to focus their inquiry on the Antikythera mechanism too. Their digital story did not fulfil the criteria. They approached the inquiry planning differently to other groups because they did not come up with their own research questions. They completed the data collection, which they interpreted as a linear process. However, their museum investigation yielded specific answers and they did not elaborate on facts to embellish their account of such with fictional elements.

Brass's digital story was about the Parthenon, a former temple on the Athenian Acropolis, which was dedicated to the goddess Athena. Their digital story did not fulfil the criteria because it consisted of incoherent narrated facts as if for an exam-like video presentation. They planned and seemed to have managed the museum investigation well, but they depended on video to illustrate their story and that impacted their plot development. Had they come up with a storyline and a character and interpreted the museum content creatively, they might have elaborated on facts to build up a plot.

The data about each group's performance revealed some diverse reports on the learning experience. The similarities and differences in each group's performance are drawn together across the data sources in the next section to find patterns that explain why for half of the groups (three out of six) crafting the digital story after the museum visit worked well and why for the other half it did not work that well.

In the first lesson, all the groups used the hand-out to develop questions that would guide their museum investigations and to determine what information they would need to collect. 'Students seemed excited to find out more about ancient technology'. They asked me questions such as 'Who made it had to do with why it was made, right?', 'Was this used for something else by later civilisations?' and 'Why do not we use this machine today?'. This showed that they were interested in the machines' function across time and social contexts,



not just their properties. The photographic data showed that all five groups at that time engaged in reading the hand-out and developing questions based on the chosen topic (see table 5.1), except for Burgundy, which used two of the prompting questions (see figure 5.2).

Group	L1 activities		
	RT	UH	WT
Alabama Crimson 1	+	+	+
Alabama Crimson 2	+	+	+
Almond	+	+	+
Artichoke	+	+	+
Brass	+	+	+
Burgundy	+	+	+
RT: reading text, UH: using the hand-out, WT: writing text.			

Table 5.1: Photographic data tags in L1 for all groups.



Figure 5.2: The Burgundy group in L1.

‘Students said that the hand-out was helpful, but it had too many questions and they would like to focus just on one or two of them’. In hindsight, Brass agreed that the hand-out had ‘many repetitive’ questions.

During the museum visit, all the groups used their smartphones and tablets to explore the museum content, collect and create relevant information. ‘Students seemed persistent to find answers to their group’s questions’. The observation findings showed that in all five of the groups the most frequently observed activities corresponded to the second stage, particularly the sub-stage 2a, with Brass also engaging in activities which corresponded to the first stage (see table 5.2).

<b>Stages with most frequently observed activities</b>	Alabama Crimson 1	Almond	Artichoke	Brass	Burgundy
1a conceptualization					
1b planning and managing				+	
2a data collection and generation	+	+	+	+	+
2b analysis and synthesis					+
3a sharing					
3b peer review and reflection					

Table 5.2: The framework stages with the most frequently observed activities among groups.

For example, they observed the objects carefully and they were able to collect information by taking notes and photographs, using their mobile devices effectively. As McFarlane (1997) claimed these mobile technologies ‘facilitate *authentic learning*, that is, learning which has personal meaning and substance for the learner’ (1997: ix, italics in original). Therefore, the findings of the most frequently observed activities agree with the literature reporting that the constructivist museum allows students to take control over their own learning (Paris et al., 1998). The outcome of which is new knowledge that derives from students’ own observations and discoveries (Yeomans, 2011). Also, I noted that ‘the fact that each group had chosen a specific topic facilitated achievement as groups did not intervene in each other’s work in the museum and students could spend time exploring the museum objects without

having to move on to the next'. Furthermore, the photographic data showed that all six groups had relatively uniform experiences in terms of interactions with the exhibits (see table 5.3).

Group	L2 activities							
	CL	RA	RT	RV	TE	TP	UH	WT
Alabama Crimson 1	+	+	+	+		+	+	+
Alabama Crimson 2	+	+	+	+		+	+	+
Almond	+	+	+			+	+	+
Artichoke	+		+	+		+	+	+
Brass	+		+	+		+	+	+
Burgundy	+	+	+	+		+	+	+
CL: close looking, RA: recording audio, RT: reading text, RV: recording video, TE: touching the exhibit, TP: taking photographs, UH: using the hand-out, WT: writing text.								

Table 5.3: Photographic data tags in L2 for all groups.

They engaged in investigative practices such as close looking at the models of the ancient machines ('[w]e looked at all the photographs and all the text under the photographs' (Brass)) but not tactually interacting with them (see figure 5.3) as in the first trial.



(a)



(b)



(c)



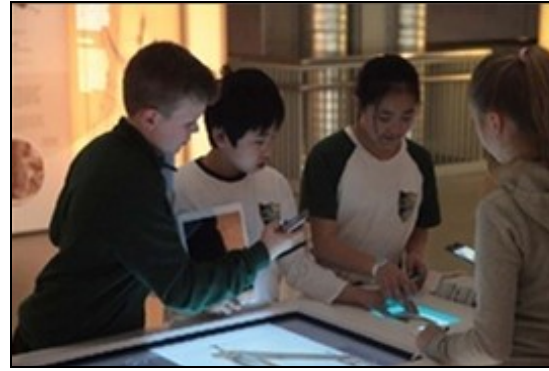
(d)

Figure 5.3: Members of the Alabama Crimson 1 (a), Artichoke (b), Brass (c) and Burgundy (d) groups observing the models of the ancient machines in the museum.

This suggests that hands-on interaction with the objects is not the only way to engage with the content. Students ‘explore in ways that pique their curiosity’ (Jeffery-Clay, 1998: 7) inside the museum, which accommodates self-initiated and self-directed explorations. This suggests that conceptual understandings are not dependent on hands-on interaction; they are enhanced by physical engagement as I noticed that ‘they enjoyed the interactive tabletop with the magnetic cards with information about the machines including details about their function and construction properties’ (see figure 5.4).



(a)



(b)

Figure 5:4: The Almond and Artichoke groups (a) and the Artichoke and Brass groups (b) in L2.

Furthermore, they were captured engaging in reading the interpretative text on the panels ('students copied text from the labels' and 'they filmed themselves reading them'), taking photographs ('it was the photographs really that tell us what we needed to know' (Artichoke)) and notes on the hand-out ('write everything down on paper in more detail' (Alabama Crimson 2)). They also recorded audio (apart from Artichoke and Brass) and video (apart from Almond, 'the video gave more information about the history of the machine' (Alabama Crimson 1)).

The post-intervention questionnaire also asked students to identify the most and least useful activities. Table 5.4 summarises per group responses, which reveal that across the six groups the most useful activity was taking photographs (followed by close looking) and the least useful activity were writing text and asking the museum guide questions.

Group	Most useful digital storytelling activity							Least useful digital storytelling activity						
	CL	TP	WT	RA	RV	TE	AG	CL	TP	WT	RA	RV	TE	AG
Alabama Crimson 1		+					+				+			+
Alabama Crimson 2		+	+	+								+		
Almond	+	+					+			+				
Artichoke	+	+			+				+	+				+
Brass	+	+	+	+	+					+				+
Burgundy	+	+	+		+				+	+				+
CL: close looking, RA: recording audio, RV: recording video, TE: touching the exhibit, TP: taking photographs, AG: asking museum guide, WT: writing text.														

Table 5.4: Per-group analysis of the most and the least useful digital storytelling activities.

The findings were consistent with the photographic data because the mid-achieving and high-achieving groups were captured in at least one photograph engaged in the most useful activities. However, the data here questioned the role of note-taking in investigatory practices and the role of the museum guide as a facilitator in material exploration. One possible explanation for the former could be that they were able to collect visual content on their mobile devices instead of writing information down. Alabama Crimson 1 said in the reflective interview that they found recording video ‘easier’ compared to note-taking. One possible explanation for the latter could be that because the museum investigation was guided by their own questions they wanted to find the answers on their own. The amount of support required from the museum guide in self-directed museum inquiries was a question that the findings of trial 1 also raised. Even so, some students seem to have assumed that they benefited the most from engaging in these two activities (taking notes and asking the museum guide questions) while others the least, and this distinction was not dependent on whether they were in a high-achieving or a low-achieving group.

In lesson 3, the photographic data showed that all the groups engaged in reading and writing text while using the storyboard (see table 5.5).

Group	L3 activities		
	RT	US	WT
Alabama Crimson 1	+	+	+
Alabama Crimson 2	+	+	+
Almond	+	+	+
Artichoke	+	+	+
Brass	+	+	+
Burgundy	+	+	+
RT: reading text, US: using the storyboard, WT: writing text.			

Table 5.5: Photographic data tags in L3 for all groups.

All the groups used the storyboard to plan their digital story by deciding on the point-of-view but none of them added information on the audio-visual effects they would like to add to increase the impact of their story. The high-achieving groups developed fictional characters, who would present through their words and actions the answers to the questions, and they drafted a script with a storyline and events (e.g. Artichoke). The only exception was Alabama Crimson 1 because they did not produce an audio narration but used video instead; an approach that did not quite pay off in terms of the storyline. The low-achieving groups either did not write a script because they had issues with writing (e.g. Almond) or they failed to produce an audio narration whose content communicated the intended messages (e.g. Burgundy). I noted that in lesson 3 ‘students found it difficult to build fictional characters with what they had collected’ even though ‘they reported they had enough information needed to answer their questions’.

In lesson 4, students imported photographs, audio narrations and videos into the software and they arranged the sequence of the photographs, used transition effects, music and/or background sounds, and they exported the digital stories by uploading them as video files to the Google Drive © folders or by sending them to me via email. ‘Students demonstrated high levels of engagement during the production stage’. The photographic data showed that all six groups engaged in synthesising the story materials and editing the digital stories on the laptops (see figure 5.5).

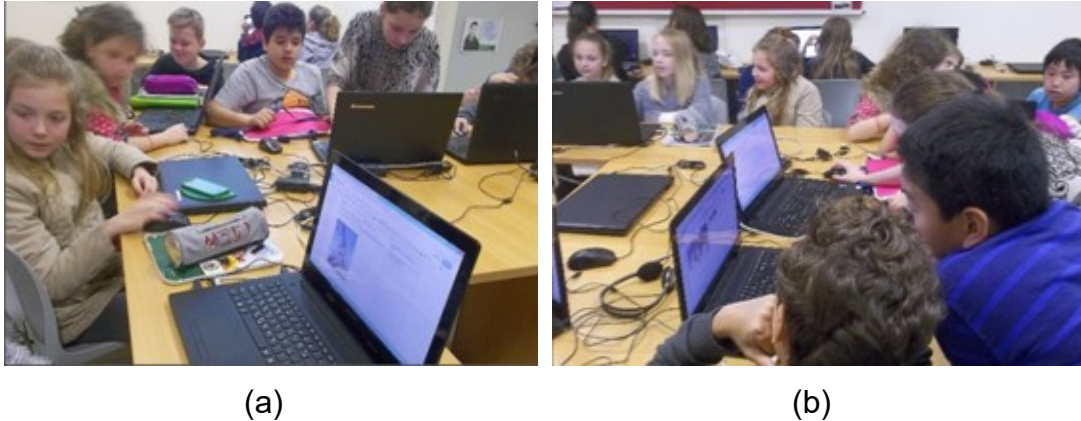


Figure 5.5: The Alabama Crimson 2, Almond and Artichoke groups (a) and the Brass and Burgundy groups (b) in L4.

The high-achieving groups presented the answers to the questions through a well-structured plot, which had a beginning, a series of events and an ending (e.g. Alabama Crimson 2) and they used their imagination to fill-in any gaps in historical information, enriching their story with fictional elements (e.g. Artichoke). They finalised the script after elaborating on the notes they had taken on the storyboard and audio-recorded it on the smartphone (except for Alabama Crimson 1). The majority of the groups (five out of six) added parts of the script as a transition effect onto some photographs but the low-achieving groups presented only facts, failing to contextualise their presentation within a well-structured plot.

The low-achieving groups failed to develop plots that presented the answers to the questions through the words or actions of characters in a series of events. Like the first trial findings, they either prioritised visual content over text without any characters or events (e.g. Almond), or they simply presented historical information (e.g. Burgundy). I noted that ‘they would like to go back to the museum to collect missing information now that they had parts of the digital story almost ready’. Not having access to the museum content while conceptualising and crafting the digital story could have hindered their efforts to organise and synthesise the information. This could be because they had collected the information while not having a story in mind, and when that story materialised they no longer had access to the information source to collect the specific information that their story required. I came to a similar conclusion as



in the first trial that it is worthy of further exploration whether an in-class writing exercise on how to fictionalise the presentation of historical information would yield different outcomes. Also, compared to the first trial, only the low-achieving groups had an issue with citing in trial 2. Nevertheless, better instruction (inform them clearly to provide credits, not just mention in the Power Point presentation the importance of referencing) should have been provided.

The averages of pre- and post-intervention student self-assessments of research skills (see figure 5.6) showed that there was significant improvement in their perceptions for all research skills competence levels with the most improvement observed in conceptualising and managing inquiry work, and data collection and analysis.

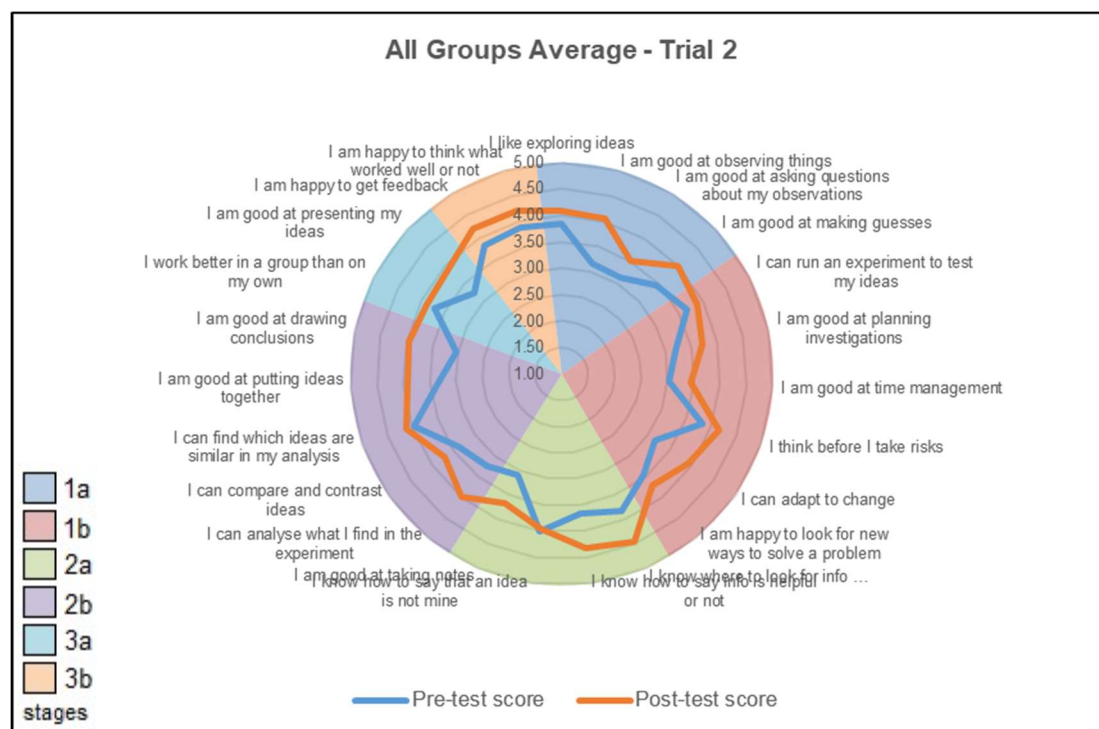


Figure 5.6: The averages of pre- and post-intervention student self-assessments of research skills.

Students were able to apply prior knowledge to conduct the museum investigations and both high-achieving and low-achieving groups benefited from analysing the collected information by elaborating on their notes. As Burgundy said 'it was kind of easy to do the research because we were

detectives you know; we were detectives in the museum. We did all the digging ourselves'. However, half of the groups had issues after the museum investigation was completed with conceptualising the digital story because they did not manage to employ their imagination to create story elements such as a character or a series of events, and blend facts with fiction. It seemed that having the digital storytelling mapped onto the inquiry process after the museum visit did not work for everyone.

### **5.2.2 A critical analysis of the emerging themes**

Four similar themes emerge from the overall findings of the six groups' learning experiences; some of which suggest reasons why the mapping of the inquiry and the digital storytelling learning processes did not work as well as in the first trial. These are: 1. The type of research questions influenced the data collection; 2. The uniformity of the students' interactions during the data collection; 3. The difficulty in turning the collected information into a story; and 4. The lack of historical information led to using their imagination.

Below, I present each theme with a detailed description of a group's performance and I discuss what the new knowledge feeds back to existing knowledge in the literature.

#### **The type of research questions influenced the data collection**

Like in trial 1, it seems that the research questions each group set in lesson 1 had an impact on their efforts to collect information without having the story in mind, which then posed a difficulty in developing a well-structured plot.

I use the learning experience of Burgundy as an example. In lesson 1 they used the hand-out to go through the prompting questions, but they did not develop their own. They chose two research questions from the ones provided. These were 'What is the Antikythera mechanism?' and 'How was it made?'. As one student put it, without it '[w]e wouldn't have particular questions to answer'.

Another student though disagreed and said that they could have asked 'different questions' instead.

During the museum visit they used the tablet and their smartphones to collect information. They were captured in at least one photograph closely observing the model and interacting with it, taking photographs (which was considered the most useful activity 'because the photograph gives you information visually'), reading the interpretative text on the panels, taking notes on the hand-out (which was considered the least useful 'because we had our phones and we did everything there because it's easier and faster'), and recording video and audio (see figure 5.7). The observation data showed that they performed greatly in creating information, organising and analysing it to draw conclusions as answers to the questions (see figure 5.8).

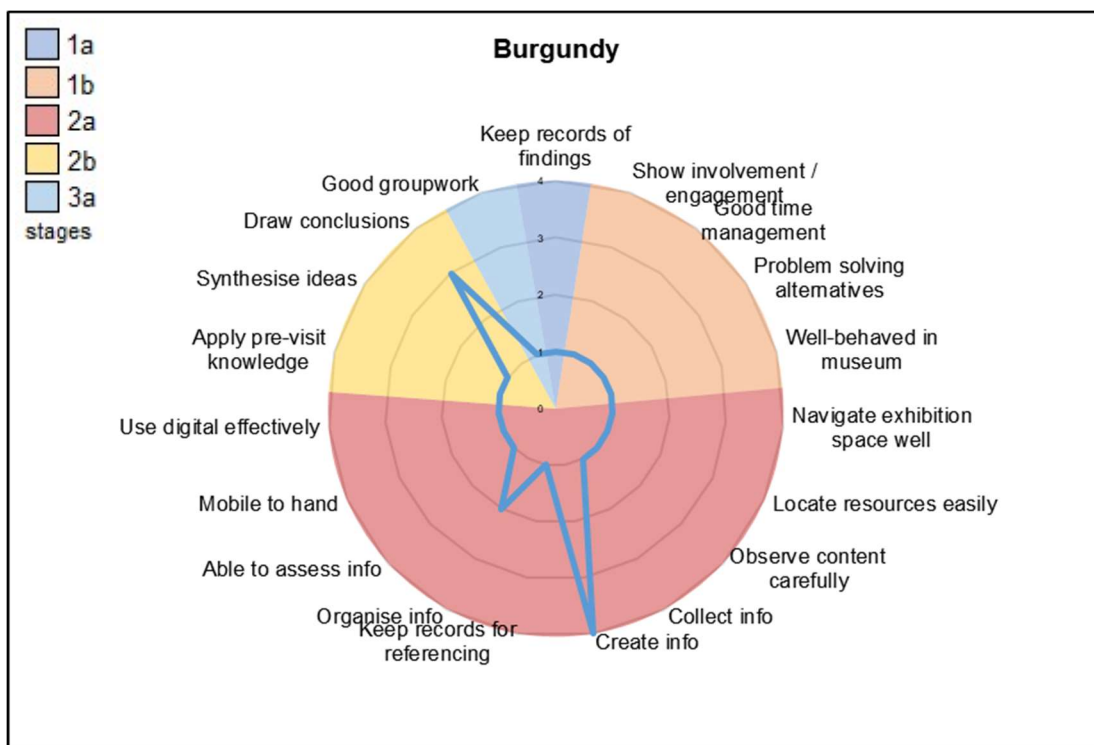


Figure 5.8: The Burgundy group's observation data.

The following extract from their reflective interview outlines how they operationalised the inquiry in a linear order:

- There was this model of the mechanism in the middle of the room and there was a poster. First we read it you know, after we took photographs and then we had like our papers and wrote down things.



(a)



(b)



(c)



(d)

Figure 5.7: Burgundy members (a) using the hand-out in lesson 1, (b) searching the museum collection for suitable material in lesson 2, (c) working on the storyboard and writing their script in lesson 3, and (f) producing their digital story in lesson 4.

In lesson 3 they drafted the script on the storyboard (see figure 5.9) without including information on audio-visual effects, using the third person point-of-view but it was descriptive as they had no characters or storyline developed.

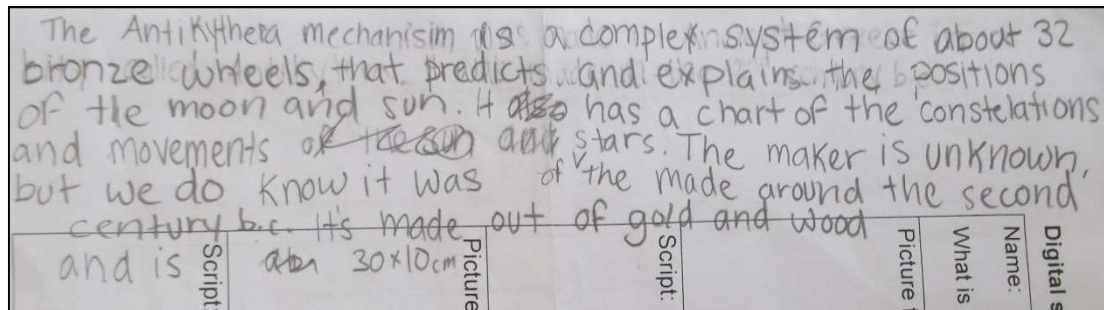


Figure 5.9: Part of the Burgundy group's storyboard.

They wanted with their digital story to entice feelings of excitement and spark the viewers' interest in the Antikythera mechanism. But even though, as they put it, 'writing the script was the base for the entire work', they only used facts. They audio-recorded their script on the smartphone and (like other groups) they added parts of it as a transition effect onto some photographs (e.g. see figure 5.10).



Figure 5.10: Screenshot from the Burgundy group's digital story.

In lesson 4 they used the laptop to produce the digital story in the Movie-Maker © software. Editing was considered 'the most boring part' because they did not have 'that many photographs to put in' since theirs were 'many of the same thing'. This could be the outcome of having no story idea or plot as a

connecting thread, or perhaps their level of engagement with the topic dropped after completing the museum investigation. Also, they faced a difficulty in manipulating the photographs ('[a]t some point like we got confused putting them together') because 'it was our first time doing it and it was difficult to do'. Even though Burgundy was the only group that reported issues with editing, this suggested that they would have benefited from better instruction on how to use the software to synthesise the story materials (e.g. upload photographs, import the audio narration, use transition effects or rendering tools). This performance was reflected in the low total score their digital story achieved, i.e. 19,84 (see figure 5.11).

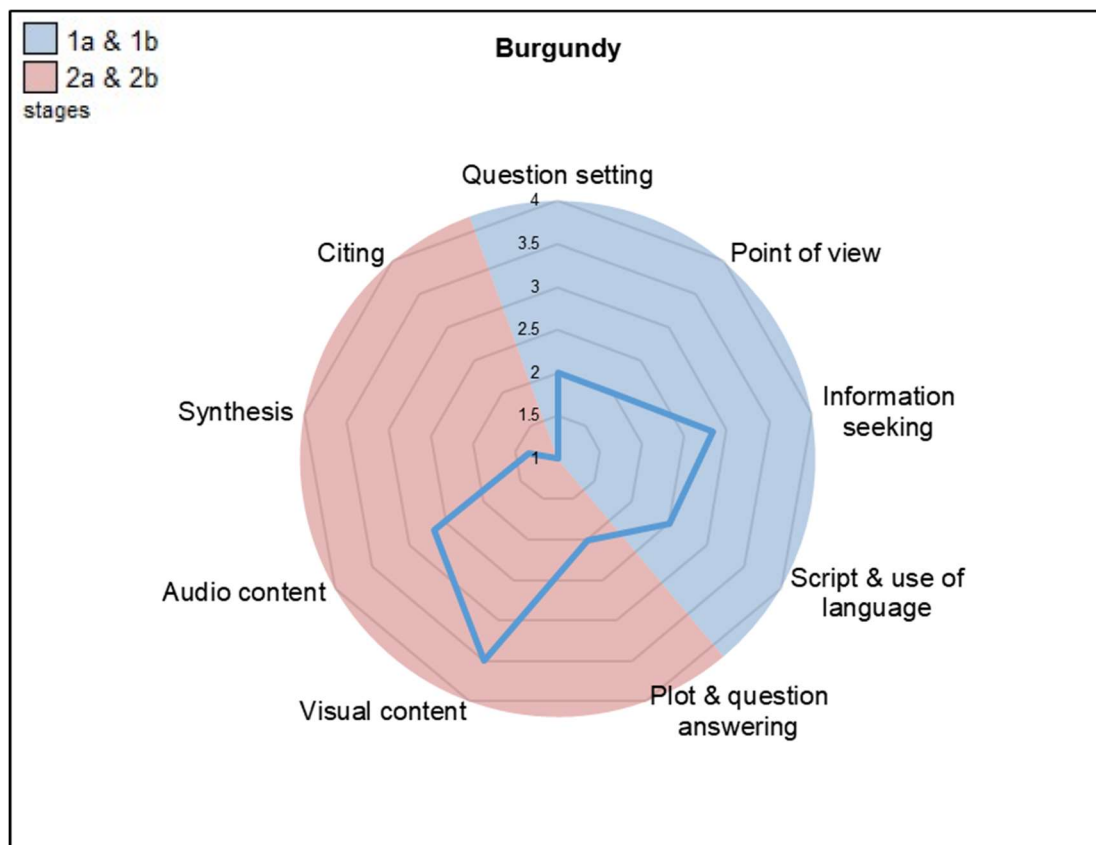


Figure 5.11: The Burgundy group's digital story score.

'Linking results to the original question under investigation is a vital aspect of interpretation which can make all the difference in ensuring that inquiry leads to the development of understanding' (Harlen, 2014: 16). Despite their evident engagement with data collection in the museum, Burgundy failed to turn the collected information into a story with a plot that would present the answers to

the questions through the words or actions of a character. Perhaps if the conceptualisation of the story did not follow the data collection or if they had access to the museum content after the museum visit, they would have been more elaborative in their narrative. This insight confirms the findings of the first trial and the literature findings. According to Littleton (2002), '[q]uestions that help them generalise from their observations will open all sorts of possibilities in all sorts of museums' (2002: 7). In this trial it appears that the synergy between the inquiry and the digital storytelling is delicate but not unachievable.

### **The uniformity of the students' interactions during the data collection**

Like in trial 1, the groups' behaviours during the museum visit were uniform. The majority of the groups engaged in similar activities, taking control over their learning. Interestingly, there is one group's performance that adds a new element to the theme: the preference of audio over video.

This group is Alabama Crimson 2. In lesson 1 they used the hand-out to come up with two research questions: 'What was the role of the trireme for the navy during warfare?' and 'What do we know about the physical features of the trireme that made it so special?'. Their digital story evolved around two fictional characters, unidentified oarsmen on board, a mentor who told his mentee war stories related to the ship. In the reflective interview they said that working on the hand-out 'helped because we knew what to look for' and as a result in the museum the questions 'made us read what they had on the walls and it made us think about the information like what was important to know'.

During the museum visit they found the exhibition section about the trireme ('it helped that everything was in the same place') and used the tablet to collect information. They said that without the tablet it 'would take a long time' to collect what they wanted. They were captured in at least one photograph engaged in close looking at the model, reading the interpretative text on the panels, which they thought 'had lots of details', and taking notes on the hand-out 'because we had to find out the details' (see figure 5.12), recording audio ('[w]e recorded with our voices reading the important information') and video,



and taking photographs, which they considered the most useful activity alongside note-taking and audio recording.

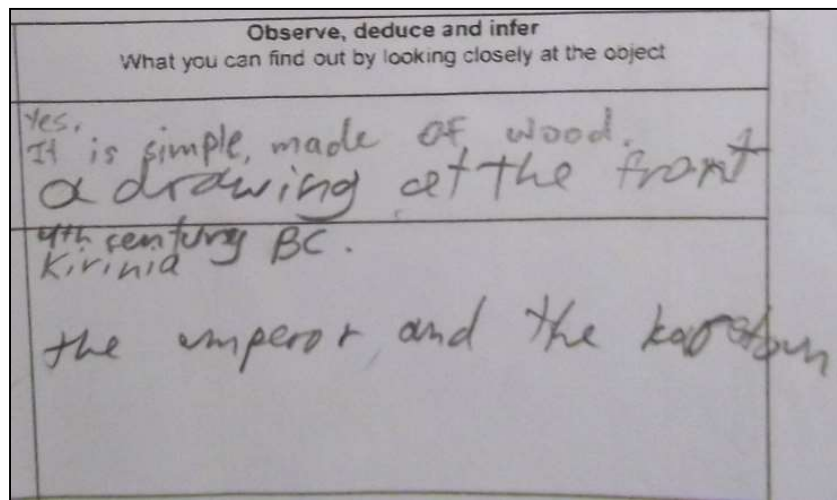


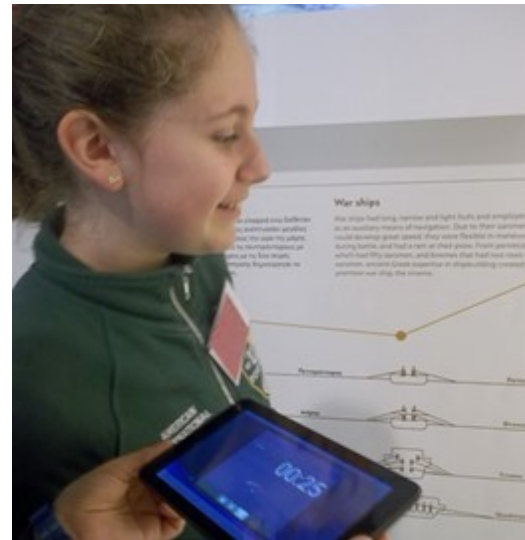
Figure 5.12: Part of the Alabama Crimson 2 group's hand-out.

They later explained that the data collection 'was a little bit difficult because we had to record everything and look for information and take videos from everything we found'. Even though guided by their questions, they found data collection a bit overwhelming because of the amount of information available in the exhibition. Their questions were technical but open-ended and they wanted to collect as much relevant information as possible.





(a)



(b)



(c)



(d)

Figure 5.13: Alabama Crimson 2 members (a) using the hand-out in lesson 1, (b) searching the museum collection for suitable material in lesson 2, (c) working on the storyboard and writing their script in lesson 3, and (f) producing their digital story in lesson 4.

In the third lesson they used the laptop to go through the materials they had collected in the museum in order to conceptualise their digital story (see figure 5.13). They used the storyboard to draft the script in the first-person point-of-view but did not include information on audio-visual effects. They wrote:

Listen boy, the Argonaut's quest for the Golden Fleece, the Odyssey, the sea adventures of gods and mortals, all tell you the sea's stories. Poseidon, god of the seas, made the sea calm or wild with a touch of

his trident. In this journey, Poseidon is our god. And the trireme is our protection. This ship here, right where we stand, dominated the Mediterranean for a thousand years. The ship led to many victories, such as in the naval battle in the straits of Salamis and became the emblem of the Athenian democracy. Why? Because of its flexibility, the metallic ram used to ram enemy ships, and us, the three rows of oarsmen who propel it forward.

The text shows how they blended facts with fiction to present the answers to the questions through the words of their characters. The plot starts with the history of the trireme, it moves on to brief accounts of events such as battles and ends with how the trireme was used as a commercial ship in the Hellenistic period to create wealth and prosperity. They described the plot development process as ‘easy to write, to put the words in and think about the photographs’ because they had the drafted script in the storyboard, and they ‘copied’ and ‘pasted it to the movie later’. This performance was reflected in the almost perfect score their digital story got, achieving 35,84 (see figure 5.14).

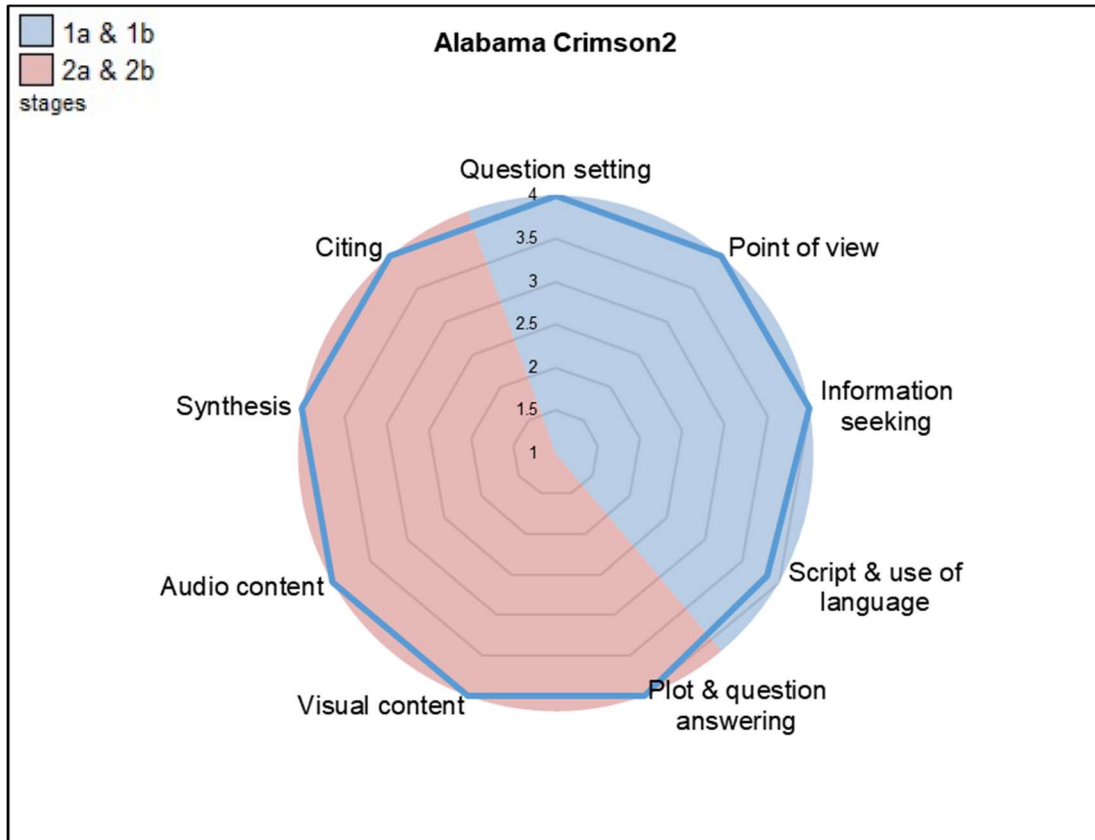


Figure 5.14: The Alabama Crimson 2 group's digital story score.

In lesson 4 they used the Movie-Maker © software to synthesise the materials. They finalised the script, audio-recorded it and imported everything into the software. For Alabama Crimson 2 the audio narration was important ‘because if we have a text and nobody is reading it, it won’t be helpful. But if somebody read it [for the viewer(s)], then it would be more helpful’. They prioritised audio content over video (which they considered the least useful activity) and they used an instrumental song to accompany the narration, which they cited.

What is more, they added parts of the script as a transition effect onto some photographs (e.g. see figure 5.15) like other groups in both trials.

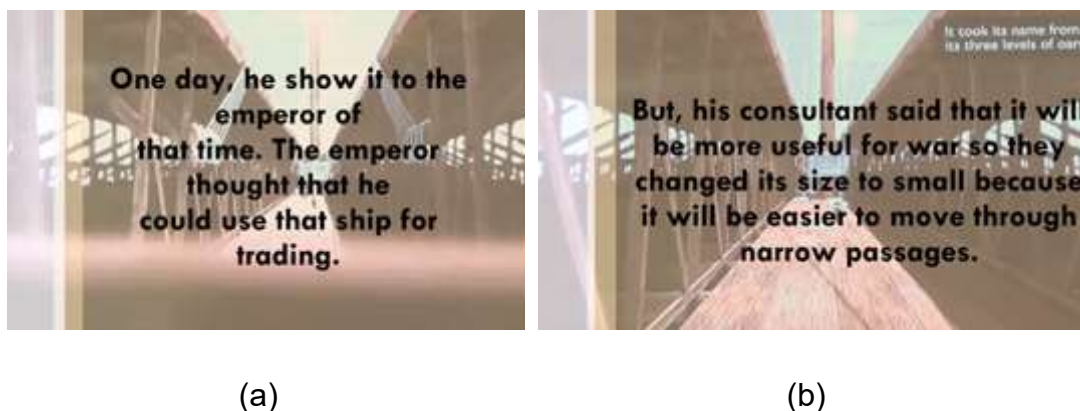


Figure 5.15: Screenshot (a) from the Alabama Crimson 2 group’s digital story is the beginning of the digital story, and screenshot (b) follows to present a twist in the plot.

Their learning experience confirms what the literature reports about the power of the self-narrated story (Lambert, 2010), capturing the lived experience and adding to the authenticity of the story. The case of museum inquiries is not different. A digital story is indeed a way to personalise and make sense of a concept and communicate this internalised knowledge in an engaging way (Andrews and Donahue, 2009; Porter, 2005).

### **The difficulty in turning the collected information into a story**

In this trial half of the groups faced a difficulty in turning facts into fiction to tell the story of the object they had investigated. Like other groups in trial 1,

students in trial 2 treated the video as a means to present as if for an exam-like presentation the answers without any attempts to elaborate on facts and interpret the content creatively, which suggested that the inquiry process took over the digital storytelling process.

Almond's performance presents an example of this. In lesson 1 they used the hand-out to develop two research questions about the machine's properties. These were 'What is the catapult?' and 'How and why was it used during warfare in ancient Greece?'.

During the museum visit the students engaged in material exploration using the tablet and their own smartphones ('for observing and zooming into things'). They were captured in at least one photograph engaged in close looking at and interacting with the model ('[t]here was the catapult and the signs for it next to it, we looked at them'), reading the interpretative text on the panels, taking photographs and notes on the hand-out (see figure 5.16).

Observe, Deduce and Infer What you can find out by looking closely at the object?
It does not have more than one
Not much it was still a war machine
it is complete
Small improvements but not much
not identifying numbers
Yes
Wood, metal and rope
Unknown
By hand

Figure 5.16: Part of the Almond group's hand-out.

The observation data showed that they performed well in locating information and assessing its relevance (see figure 5.17).

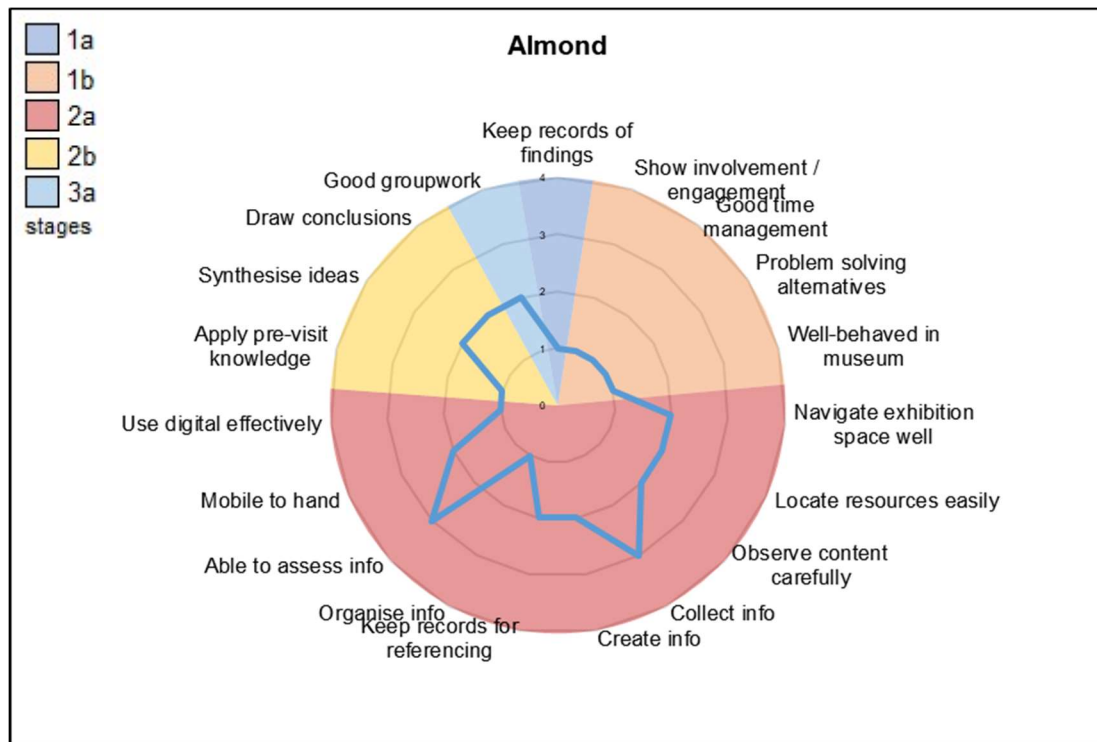


Figure 5.17: The Almond group's observation data.

They later explained that '[m]ost of the things that we got for the digital story was from reading the information that was on the walls' and asking the museum guide questions 'to get some more information'.



(a)



(b)



(c)



(d)

Figure 5.18: Almond members (a) using the hand-out in lesson 1, (b) searching the museum collection for suitable material in lesson 2, (c) working on the storyboard and writing their script in lesson 3, and (f) producing their digital story in lesson 4.

In lesson 3 they started planning the digital story on the storyboard, which they did not find useful because it required too much writing ('the information had to be mixed with like too much details'). They did not draft a script or any characters. Instead they consulted the notes on the hand-out to arrange the photographs in an order that fit the answers to the questions (see figure 5.18). This insight confirms previous studies about the poor connection found between students' investigative practices and the crafting of the digital stories ((Murmann and Avraamidou, 2016). And it suggests that in order to deal with the difficulty in turning facts into fiction, students should plan their stories before the data collection for the story idea to guide their investigation.



In lesson 4 they imported the photographs into the Movie-Maker © software and started editing. They just added factual information as a transition effect onto some photographs (e.g. see figure 5.19) without working on the text to implement fictional elements such as the words of a character, personal thoughts, imaginary events or interpretations of historical events.



Figure 5.19: Screenshot from the Almond group's digital story.

Instead of producing an audio narration, they used brief audio recordings of themselves reading from the panels. Contrary to other groups, which also paired text with photographs in editing, theirs consisted of historical information only (constituting the video more of an exam-like presentation) without fictionalising. In the questionnaire they reported that writing text was the least useful activity, which suggested that some groups may require better scaffolding to enable them to use historical information creatively and imaginatively. One student said in the reflective interview that 'all we learned in the museum I could just find in Google ©, like google information about the catapults and work on the answers in the classroom'. Perhaps after the museum visit, they would have benefited from visiting the museum's website and digital collection in planning and producing the story. But it seemed that they were not successful in generating story materials not because they had not found enough relevant information (their digital story scored high in visual content and moderately high in information seeking) but because the inquiry process took over the digital storytelling process. As a result, their digital story

got a low total score of 20,48, scoring low in question setting, script development, plot development and question answering, and in audio content because they had no audio narration (see figure 5.20).

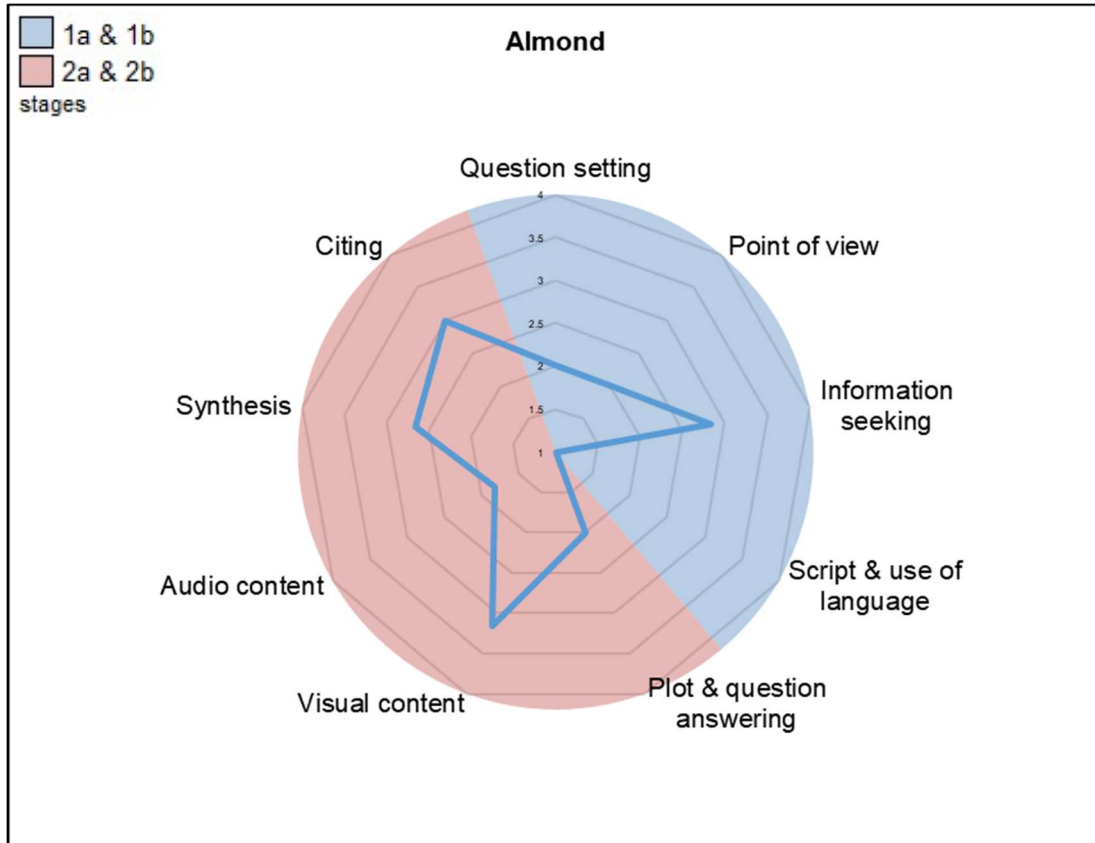


Figure 5.20: The Almond group's digital story score.

A pattern seems to emerge for low-achieving groups, who seem to have approached the task as they would approach the answering of an exam question, by relaying facts and data, and failing to allow creativity to creep into the question answering process. This is an important insight with respect to story-driven personal interpretation of the museum content. 'Nowadays, many museums [...] make extensive use of narrative, or story-telling as an educative, interpretive and meaning-making tool' (Glover-Frykman, 2009: 300). In museum inquiries though, looking for answers to specific questions might overshadow that aspect of engagement. In that case, students might benefit from having planned their stories before the data collection for the story idea to guide their investigation, allowing creativity to find its role into the process.



## The lack of historical information led to using their imagination

Another theme that appears is that mid-achieving and high-achieving groups found a way to deal with the lack of historical information and fill-in the gaps in the materials by using their imagination.

I use Artichoke's learning experience as an example. Artichoke used a series of photographs to tell the story of the Antikythera mechanism. They created an unidentified fictional character that supposedly excavated it from the bottom of the ocean during one of his travels. The plot was built around his narrating the events of the astronomical mechanism's construction, function and excavation. In lesson 1 they used the hand-out to develop two research questions: 'What makes the Antikythera mechanism special?' and 'How was it built, by whom, what was it used for and who found it?'. They said that the hand-out helped them come up with their own questions and determine 'what to look for'.

During the museum visit Artichoke performed greatly in observing the model and assessing the relevance of the collected information (see figure 5.21).

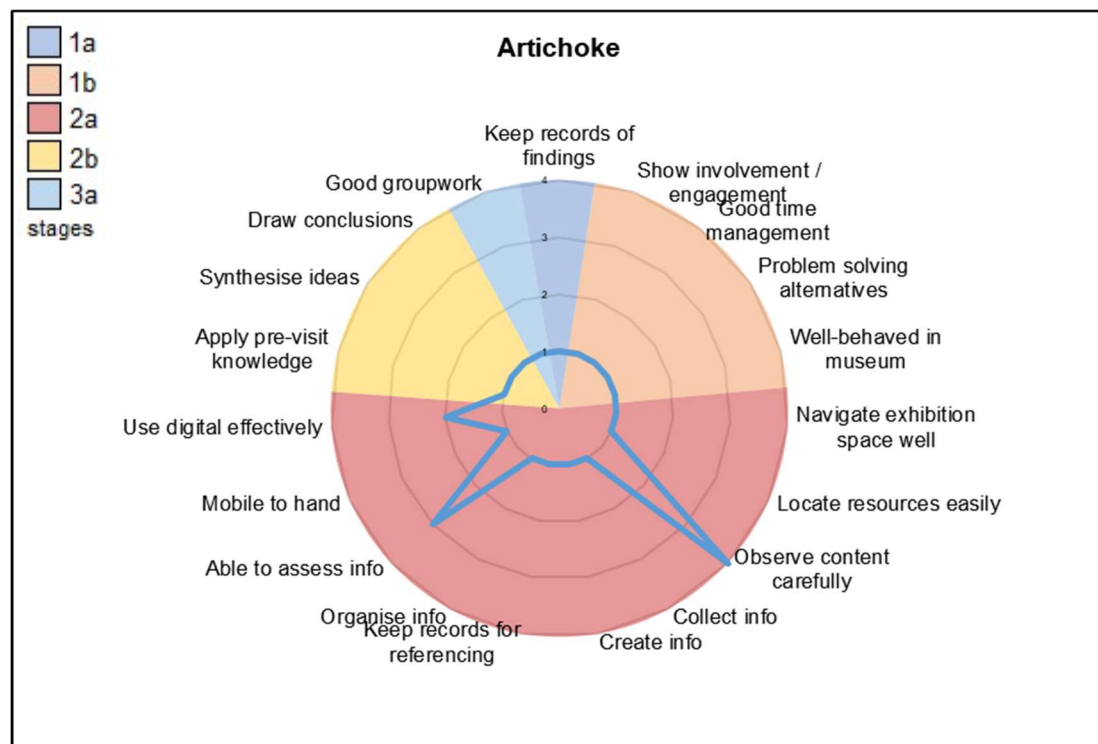


Figure 5.21: The Artichoke group's observation data.

They were captured in at least one photograph engaged in reading the interpretative text on the panels, interacting with the model (which they found to be the most useful activity), taking photographs, recording video and taking notes on the hand-out about its physical features (see figure 5.22), but not recording audio.

Find an Object	
Observe, Deduce and Infer	
What you can find out by looking closely at the object?	
<ul style="list-style-type: none"> <li>• About 90 cm.</li> <li>• Rectangle (3D); wood, don't know</li> <li>• Brown &amp; gold</li> <li>• Yes</li> <li>• No</li> <li>• No</li> </ul>	<ul style="list-style-type: none"> <li>• Surface smooth</li> <li>• No, but letters</li> <li>• Yes</li> </ul>
<ul style="list-style-type: none"> <li>• We don't know</li> <li>• It was made by adding different pieces of material together. In video.</li> <li>• Hand made</li> <li>• Yes</li> </ul>	

Figure 5.22: Part of the Artichoke group's hand-out.

One student reported that taking photographs was not very useful 'because they [the photographs] can give information but they cannot show people how something works unless it is written down and explained'. Another student added though that 'the photographs helped us create our story'. This meant that, for Artichoke, even though writing text was given priority, photographs served illustration purposes as well.

They described the data collection as 'a bit hard' because they could not find all the answers to their questions '[b]ecause they didn't say like who created it or they didn't know' (see figure 5.23). But lacking historical information was perhaps responsible for their using their imagination to craft this particular character who supposedly found the Antikythera mechanism. This meant that even though the overlap between the inquiry and the digital storytelling processes might not be straightforward, the two processes might complement

each other in character and/or events development because the students are free to fill-in any gaps in facts with fictional elements.



(a)



(b)



(c)



(d)

Figure 5.23: Artichoke members (a) using the hand-out in lesson 1, (b) searching the museum collection for suitable material in lesson 2, (c) working on the storyboard and writing their script in lesson 3, and (f) producing their digital story in lesson 4.

In lesson 3 Artichoke chose the third-person point-of-view and drafted the script with the emotional intent to entice the viewers' curiosity and interest in

this ancient technological achievement. They did not include information on audio-visual effects within the storyboard, but they said that it was useful 'because it helped us plan how we were going to do the actual story [...] we wouldn't be able to really understand the Antikythera mechanism if we didn't organise ourselves and see what we found to show it'.

In lesson 4 they worked on the final version of their script. They wrote:

In his travels, he had seen many things. Treasures, monsters and unbelievable beauty. But he had never seen such a thing before. Was it science? Was it technology? Was it Poseidon himself? He found it buried in the ocean, under the deep seas. A 30 cm long wooden computer with incredible mathematical details on its golden metallic inscriptions. It was for sure not built in one day. It had so many parts, different things all put together carefully with a logic. It was used to predict astronomical happenings because its measurements were accurate. People trusted it like they trusted their gods.

The text shows how they managed to blend facts with fiction and present the answers to the questions they had set. This insight confirms what the literature reports about the synthesis of information in such a way that presents the findings and answers the question(s) set using evidence (Stepien and Gallagher, 1993). As one member explained, 'I think our script is less a documentary and more like an actual story. Because we have things we made up and we have added just real things too'. But instead of audio-recording the script, they decided to add it all as transition effects onto the photographs (e.g. see figure 5.24) like other groups in both trials, which had an impact on the score their digital story got in audio content.



(a)



(b)

Figure 5.24: Screenshot (a) from the Artichoke group's digital story shows parts of the script presenting the properties of the object, and screenshot (b) shows the contextualised information within the plot.

To synthesise the story materials, they used the Movie-Maker © software. The plot had a beginning, focusing on how the mechanism was found, a middle with the description of its properties and information about its function, and an end with their interpretation of why it is so special (see figure 5.25).

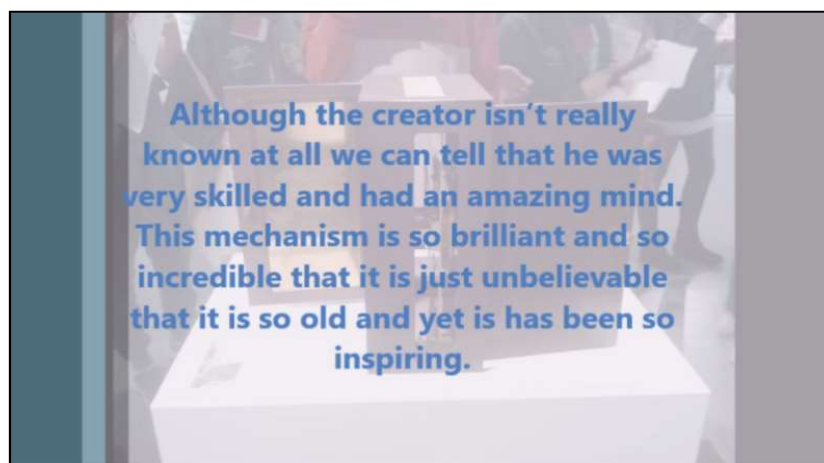


Figure 5.25: Screenshot from the Artichoke group's digital story.

In hindsight, they said:

[T]he analysis helped because we could get it all by looking at it. Technically, we had all the information that we wanted when we were in the museum. But with this video story we could see exactly how to do it without going back to the museum and looking at the writing again.

This comment confirmed that taking photographs and notes were useful activities for their museum investigation. They presented the answers by organising the collected information in a chronological order. In agreement with the literature review findings, through inquiry students internalised knowledge that then was subjected to inference and explanation (Allen et al., 1986; Kyle, 1980; Gallagher, 2006). As a result, their digital story scored really high in almost all the criteria, getting a score of 29,84, except for audio content and citing because they did not have the script audio-recorded (see figure 5.26).

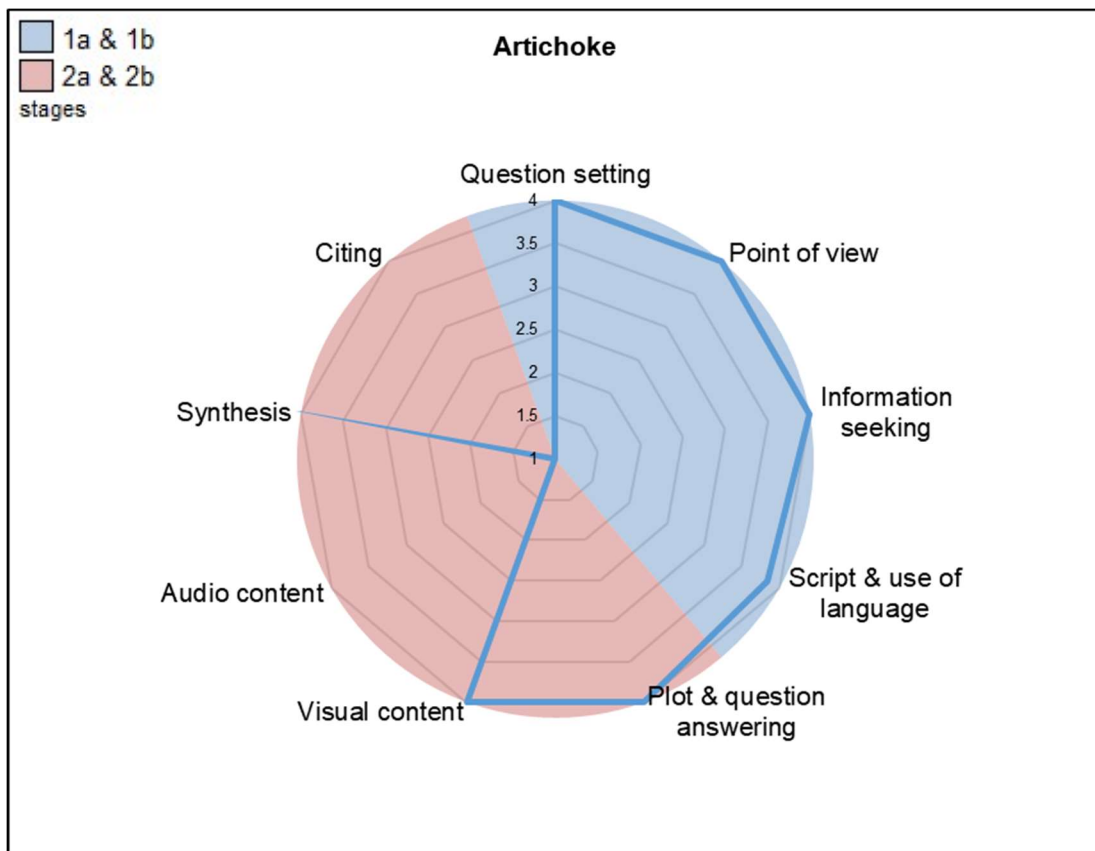


Figure 5.26: The Artichoke group's digital story score.

Their learning experience shows that when the story production comes after the data collection, students might find it difficult to develop a plot because information might be missing. But by resorting to creative writing they might envision missing parts and add other parts to the historical information and complete it in a compelling way. This confirms what the literature reports about the importance of prompting students to use their creativity in the synthesis stage (Robin, 2008).

### **5.3 Improving the intervention**

After performing the data analysis, I decided to change the order of lessons back to the one used in the first trial, i.e. conceptualising the digital story before the museum visit, because half of the groups were not successful in producing a digital story that fulfilled the requirements. Also, I decided to double the number of the lessons for the intervention from four to eight to give them more time for the tasks of each stage (especially for data collection and the story production). Equally important was my decision to set the museum inquiries in the digital collection of the V&A museum. This made it possible for the students to have access to the museum content after completing the data collection. By doing so, I expected there would be a more dynamic interplay between the inquiry and the digital storytelling processes.

### **5.4 Summary**

The objectives of the second trial were to try out the different order of the lessons and explore possible answers to the research questions by analysing the second set of data. The findings presented here are informative because they led to changes in the instruction and research designs necessary to gain a better understanding of how the digital storytelling process overlaps with the inquiry-based learning process in the *DiStoMusInq* framework.

## Chapter Six

### Trial 3: Imagining life in the Victorian Era

#### 6.1 Introduction

The third trial took place in May-June 2017 at Pinewood school and included a class of 24 15-17 years-old students who ‘visited’ the V&A’s digital collection in the course of planning and undertaking group inquiries based on the Victorian Era as part of their English Literature subject. I conducted this final trial to try out the implementation of the *DiStoMusInq* framework in a web-based setting, thus better situating the study within the context of the literature, and to better understand how effective digital storytelling can be in framing students’ museum inquiries. Students used the museum’s service *Search the Collections* to collect information about their chosen topic of life in the Victorian Era (e.g. factory life, marital life or political events) and craft a digital story that would present how they reached new understandings of it. In this trial the physical museum visit was replaced by an online visit to a museum (during lessons 3 and 4) that holds collections relevant to the curriculum. The findings of the third trial show the emergence of five similar themes that confirm the symbiotic relationship between the inquiry-based and the digital storytelling learning processes, suggesting that the mapping of the two using the *DiStoMusInq* framework is successful if certain considerations are made. These relate to the type of questions students set for their museum investigations, the required flexibility during as well as after the data collection to adjust story plans to the returned search results, allowing for fictional elements to be added to any missing historical information, the liberty to use other sources and the need for technical training in using the software for editing during the synthesis stage.

This chapter presents the data obtained from the third trial and the analysis performed. Section 6.2.1 is a synthesis of the overall findings looking across groups and data sources to discuss how the students performed in each stage of the *DiStoMusInq* framework. Section 6.2.2 is a critical analysis of the



emerging themes with references to the relevant literature. And section 6.2.3 presents the findings from the post-intervention teacher interview.

## 6.2 Data presentation and analysis

### 6.2.1 Overall findings across groups and data sources

Based on the total scores of the digital stories (see figure 6.1), the high-achieving groups were Alloy Orange, Arylide Yellow, Azure, Beau Blue, Begonia and Bistre, with Begonia, Beau Blue and Bistre outperforming the other three in stage 2-related scores. The low-achieving groups were Absolute Zero and Bronze, by virtue of not submitting a story.

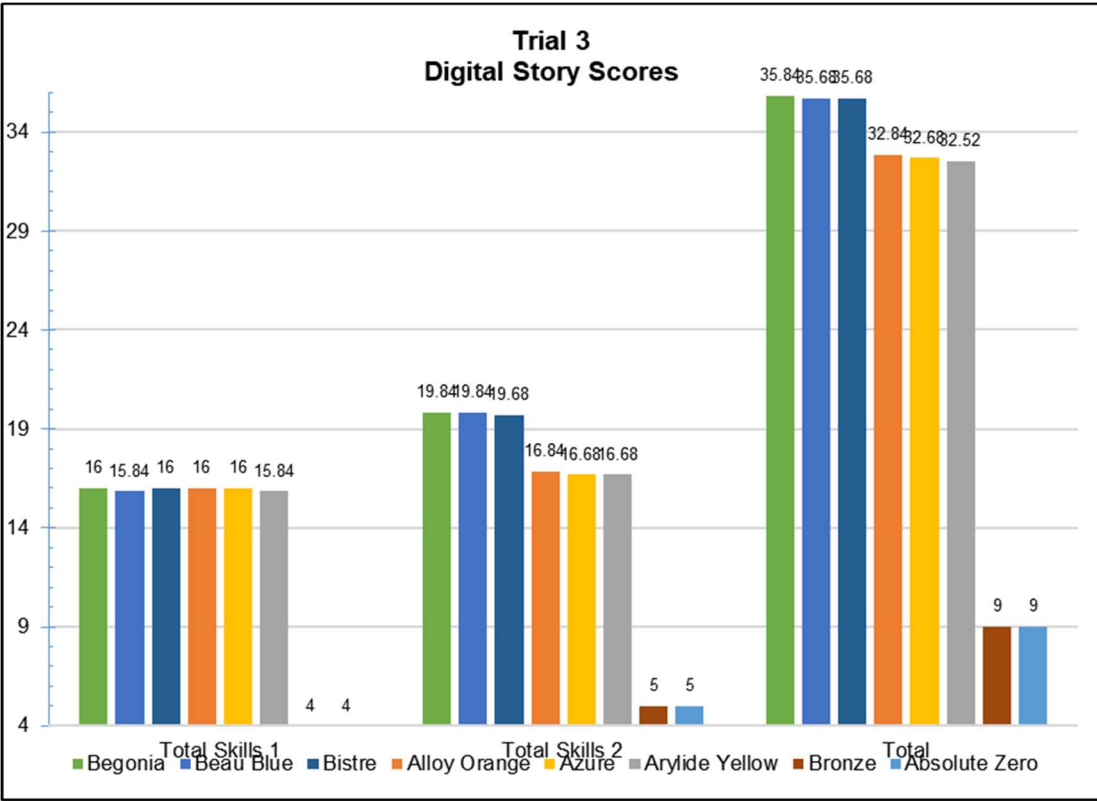


Figure 6.1: All the groups' digital story scores.

### The high-achieving groups

Begonia wanted to look into motherhood, and they focused their inquiry on the mother-daughter relationship during a wedding preparation. Even though they

had chosen a very specific topic to investigate and it was not easy to find enough relevant photographs, they were able to produce a digital story that fulfilled the criteria because they were flexible to map their story to the returned findings. They blended facts with fictional elements and presented the answers to their questions within a well-structured plot.

Beau Blue chose to look into factory life, focusing on the staff manager. For Beau Blue, framing the inquiry around the story 'narrowed the search' but they did not want to alter their plans. They used the available visual content, including externally sourced story materials, and they depended on the audio narration and the music to communicate the intended messages. Their digital story fulfilled the criteria.

Bistre also chose to work on factory life, focusing on the owner (Mr Burgess). Their digital story fulfilled the criteria. They planned and conducted the web-based museum investigation successfully despite the difficulty of finding enough visual content and an issue with editing. They built up a storyline with a plot that presented the answers to their questions in a compelling way.

Alloy Orange decided to look into political and social reforms and crafted a digital story about a fictional feminist uprising. Their digital story fulfilled the criteria. Their choice to use a historical period as the backdrop of their story but not connect the story with specific historic events meant that they had some degree of flexibility in adjusting their story to match their discoveries from the digital collection. Taking inspiration from Emily Bronte, they constructed a character whose biography matched the socio-political context of the period. Their protagonist being a fictional character with a fictional biography initially presented the group with difficulties in finding related content in the museum collection. They adjusted to these difficulties by finding content that was as close as possible to the needs of the story, and then adjusting the story to achieve a better match.

The Azure group opted for a digital story about the Suffragettes movement in the late-19<sup>th</sup> century. Their digital story fulfilled the criteria. Their data collection

was guided by this specific setting, which yielded limited information. They managed to solve their problem of not finding enough relevant photographs by drawing the illustrations themselves.

Arylide Yellow wanted to tell a story about child labour in factories and look into the working conditions of lower-class families. Their digital story fulfilled the criteria. Like other groups, they had a difficulty in mapping the returned findings to their storyline. But they took a staged approach to combining the two processes, using the knowledge they gained from the digital collection to progress their story crafting; and using their developing story to further interrogate the digital collection.

### **The low-achieving groups**

Absolute Zero focused their inquiry on factory life. They planned the web-based museum investigation based on their questions and story idea; but it was not straightforward how to map the collected information to their story plan. This is why they went back and forth to the digital collection and they used the returned findings in developing a plot that combined factual information with their ideas. They started crafting the digital story, but they did not finish it because of poor time management.

Bronze's idea was to look into the political scene of the Victorian Era. They successfully planned and conducted the web-based museum investigation as they found photographs of drawings and portraits and worked on editing the digital story until the end of lesson 7. But they did not submit a digital story because the video was not saved properly.

The data about each group's performance revealed relatively uniform reports on the learning experience. The similarities and differences in each group's performance are drawn together across the data sources in the next section to find patterns that explain why for the majority of the groups (six out of eight) the mapping worked really well.

In the first lesson, all the groups used the hand-out to develop questions that would guide their web-based museum investigations and to determine what information they would need to collect. ‘Students showed familiarity with the stages of the inquiry-based learning process and interest in how they could apply prior knowledge in the museum context’. They asked me questions such as ‘Can we look for objects they used in daily life?’, ‘What if our point of view is biased because we manipulate the information?’ and ‘How much can we trust the information in the museum?’. This showed that they wanted to get from the digital collection accurate and reliable information to represent life in the Victorian Era. The photographic data showed that all eight groups engaged in reading the hand-out and developing questions based on the chosen topic (see table 6.1).

Group	L1 activities		
	RT	UH	WT
Absolute Zero	+	+	+
Alloy Orange	+	+	+
Arylide Yellow	+	+	+
Azure	+	+	+
Beau Blue	+	+	+
Begonia	+	+	+
Bistre	+	+	+
RT: reading text, UH: using the hand-out, WT: writing text.			

Table 6.1: Photographic data tags in L1 for all groups.

Two of the high-achieving groups (Azure and Begonia) expressed diverse opinions on how useful the hand-out was. It seemed that they did not really need the prompting questions, but they consulted them to form their own questions (e.g. Arylide Yellow, see figure 6.2).



Figure 6.2: The Arylide Yellow group in L1.

In lesson 2, the photographic data showed that all eight groups engaged in reading and writing text while using the storyboard (see table 6.2).

Group	L2 activities		
	RT	US	WT
Absolute Zero	+	+	+
Alloy Orange	+	+	+
Arylide Yellow	+	+	+
Azure	+	+	+
Beau Blue	+	+	+
Begonia	+	+	+
Bistre	+	+	+
Absolute Zero	+	+	+
RT: reading text, US: using the storyboard, WT: writing text.			

Table 6.2: Photographic data tags in L2 for all groups.

All the groups used the storyboard to start developing their scripts from a specific point-of-view but none of the groups included information on the audio-visual effects they would like to add to enrich their story. It seemed that they were not interested in this at the planning stage like some groups in the first

and second trials were. What I found interesting was that half of the high-achieving groups (Arylide Yellow, Beau Blue and Bistre) approached the planning stage differently than the other half (Alloy Orange, Azure and Begonia). The former conceptualised the digital story by developing a less structured plan, i.e. a 'very basic storyline and idea' (e.g. Arylide Yellow who at that point did not know 'what the script will be about'); while the latter detailed the characters' actions and words (e.g. Begonia, see figure 6.3).



Figure 6.3: The Begonia group in L2.

Like the first and second trials, the first grouping of high-achieving groups was able to fully develop the story only after they had commenced the web-based museum investigation as they adjusted the story plans according to the search results. Whereas the second grouping of high-achieving groups was not so flexible in the early stages as to deviate from their story plans. Interestingly, in this trial flexibility in the early stages of plot development was not a predictor of high performance: even groups that committed to the specifics of a story early on were able to 'pull it off' and develop a high scoring digital story. I noted in particular that 'students had no difficulty building fictional characters and events'. There are several possible explanations for this: perhaps it was the subject that encouraged them to be creative and elaborative in how they embedded factual information in their narratives; or the types of questions they

had set, which were generally more open-ended than in trials 1 and 3 and which guided their data collection, yielded findings that were more open to interpretation and manipulation; or the students' prior knowledge of the topics from the literature covered in class that helped them build on existing understandings (e.g. Azure and Bistre who used prior knowledge of the social context for their script development).

In lessons 3 and 4, all the groups used their smartphones and laptops to access the digital collection and collect and create story materials. They used keywords to find, select and download information and visual content for their digital stories. The observation findings showed that in all the groups the most frequently observed activities corresponded to all the stages of the framework (see table 6.3).

<b>Stages with most frequently observed activities</b>		Absolute Zero	Alloy Orange	Arylide Yellow	Azure	Beau Blue	Begonia	Bistre	Bronze
1a conceptualization	L3		+	+	+				
	L4		+			+		+	
1b planning and managing	L3		+	+	+	+	+	+	+
	L4	+	+	+	+	+	+	+	
2a data collection and generation	L3	+	+	+	+	+	+	+	+
	L4	+	+	+	+	+	+	+	+
2b analysis and synthesis	L3		+	+	+	+	+	+	
	L4				+			+	+
3a sharing	L3			+	+		+		+
	L4	+	+	+			+	+	+
3b peer review and reflection	L3			+	+		+		+
	L4	+	+	+			+	+	+

Table 6.3: The framework stages with the most frequently observed activities among groups.

For example, they showed increased engagement and they seem to have understood the purpose of the data collection, which related to the first stage of the framework. These findings confirm previous studies about the use of web-based resources for investigations in scenario-driven contexts at school

for the development of research skills (Wishart and Triggs, 2010), resulting in high levels of engagement (Mikroyannidis et al., 2013). Students could locate information in the digital collection effectively, using keywords and assessing the returned findings, which related to the second stage. And they demonstrated good group work, which related to the third stage. Both high-achieving and low-achieving groups completed the data collection. Students described the process as ‘listening to our story’ (Absolute Zero) and explained that they did not ‘really need the information to be true’ (Beau Blue) because they could enrich it with fictional elements. In fact, for some of the groups in this trial the commitment to the stories was so strong that they opted for creating visual material to fit their needs and/or looking for material outside the museum website, rather than adjusting the stories to fit the material they could find on the museum website. This commitment may have been a consequence of the groups’ affinity for the topics they had chosen as discussed earlier.

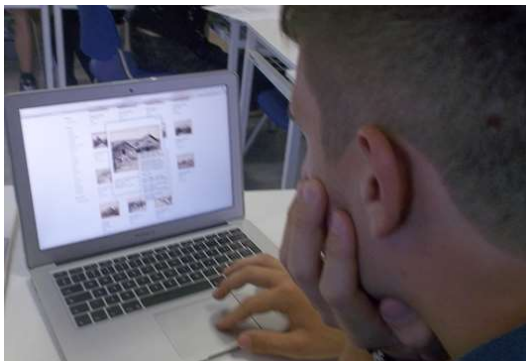
Furthermore, the photographic data showed that all eight groups had uniform experiences in terms of interactions with the digital collection for museum content exploration in lessons 3 and 4 (see table 6.4).

<b>L3 + L4 activities</b>		Absolute Zero	Alloy Orange	Arylide Yellow	Azure	Beau Blue	Begonia	Bistre	Bronze
CL	L3	+	+	+	+	+	+	+	+
	L4	+	+	+	+	+	+	+	+
RT	L3	+	+	+	+	+	+	+	+
	L4	+	+	+	+	+	+	+	+
TP	L3	+	+	+	+	+	+	+	+
	L4	+	+	+	+	+	+	+	+
UK	L3	+	+	+	+	+	+	+	+
	L4	+	+	+	+	+	+	+	+
US	L3		+		+	+	+	+	+
	L4	+	+	+	+	+		+	+
WT	L3				+	+	+		
	L4		+		+	+	+	+	+
CL: close looking, RT: reading text, TP: taking photographs, UK: using keywords, US: using the storyboard, WT: writing text.									

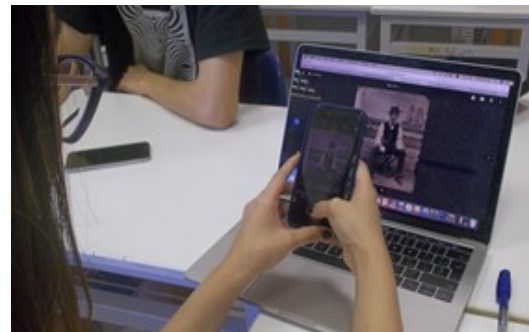
Table 6.4: Photographic data tags in L3 and L4 for all groups.



They engaged in investigative practices such as close looking at the photographs that came up in the searches ('close looking helped to get a better, detailed view of the object', Arylide Yellow), reading their descriptions and downloading or taking screenshots of the relevant photographs ('we looked at the photographs that we needed', Bistre), and taking notes on the storyboard ('taking notes helped because I could remember things and details about the objects', Bronze) (see figure 6.4).



(a)



(b)



(c)



(d)

Figure 6.4: Members of the Absolute Zero (a), Arylide Yellow (b), Beau Blue (c) and Begonia (d) groups conducting the web-based museum investigations in lessons 3 and 4.

However, the majority of the groups (six out of eight) faced an issue with the number of relevant photographs available in the digital collection, particularly the three high-achieving groups that were not so flexible early on to modify their story plans according to the search results. The students overcame that challenge by looking for photographs in other websites (Alloy Orange, Arylide Yellow, Beau Blue and Bistre), by drawing sketches themselves (Azure) or by

altering their scripts to match the collected information (Begonia and Bronze) (see figure 6.5).



Figure 6.5: Members of the Arylide Yellow (a) group browsing for photographs on Pinterest © and members of the Begonia (b) group adjusting the script in lesson 4.

These findings suggested that certain flexibility in the storyline is required to match the returned search results, possibly suggesting that the types of questions set influenced the quantity and relevance of visual content found and hence the quality of the digital story. I came to a similar conclusion as with low-achieving groups in trials 1 and 2 that perhaps they would have benefited from being given more time for data collection or if they were given access to other museum websites too because they should be able to interpret the information and integrate it more firmly into their understanding (Maniotes et al., 2016). It is possible that they would benefit from combining the physical museum visit with visiting the digital collection of a museum. For example, they might do preliminary online searches, guided by their story idea, then plan for the story according to the returned outcomes, and then visit the museum to collect information and create story materials onsite.

The post-intervention questionnaire also asked students to identify the most and least useful digital storytelling activities for their museum investigations. Table 6.5 summarises per group responses, which reveal that across the eight groups the most useful activity was taking photographs and writing text

(followed by close looking) but writing text was also perceived by some members within the same groups as the least useful activity.

Group	Most useful digital storytelling activity				Least useful digital storytelling activity			
	CL	TP	WT	RA	CL	TP	WT	RA
Absolute Zero	+	+	+					
Alloy Orange	+	+	+	+	+		+	
Arylide Yellow	+	+	+	+	+			+
Azure	+	+	+	+			+	
Beau Blue		+	+					
Begonia	+	+	+					
Bistre		+	+				+	
Absolute Zero	+	+	+	+			+	
CL: close looking, TP: taking photographs, WT: writing text, RA: recording audio (the script).								

Table 6.5: Per-group analysis of the most and the least useful digital storytelling activities.

The findings were consistent with the photographic data which also captured both high-achieving and low-achieving groups were captured in the activities listed as most useful. The discrepancy about writing text cannot be explained because (except for Bronze that did not submit a digital story) the four groups that listed it as least useful actually scored high in script and plot development, particularly Azure who paraphrased actual quotes and Bistre who used colloquial slung. Bistre explained though that ‘writing the final script based on that information was not all useful because it had lots of details we did not really need’. It is worthy of further exploration how students would negotiate roles to share expertise or responsibility for script development in an in-class writing exercise. In doing so, they might help each other decide which information to use and which unnecessary details to disregard and develop a complex plot with twists or events that highlight aspects of their characters’ life. As part of such an exercise they might work on re-drafts of the script and apply this how-to-edit/review knowledge in diagnosing future problems with story structure. Besides that, all eight groups developed well-structured plots with

events and fictional characters, who presented through their words and actions the answers to the questions.

In lessons 5 and 6, students imported photographs and audio narrations into the software, and they arranged the sequence of the photographs, used transition effects, music and/or background sounds, and worked on editing the digital stories on the laptops (see figure 6.6). The findings revealed that as the literature suggests (Liguori et al., 2018) the digital stories students crafted were evidence of their sense-making about historical events and locations, and as such exposed how scenarios inspired by the collections can frame content-specific knowledge acquisition.



(a)



(b)



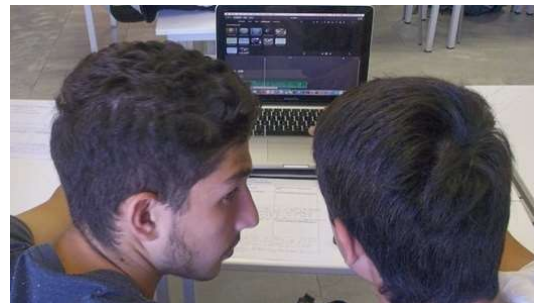
(c)



(d)



(e)



(f)

Figure 6.6: Members of the Alloy Orange (a), Arylide Yellow (b), Azure (c), Beau Blue (d), Bistre (e) and Bronze (f) groups producing the digital stories in lessons 5 and 6.

I noted that 'it was common practice to experiment with the editing features' among all groups. However, two groups (Alloy Orange and Bistre) faced the same issue with sequencing the photographs: it was difficult 'to match them with the recorded voice' and had to make them last longer to match the audio

narration. What is more, three groups (Beau Blue, Begonia and Bistre) said that they would have liked to use a different software that would have allowed them to create something 'more visually pleasing'. And citing appeared to be a recurring issue with the majority of the groups because only Beau Blue, Begonia and Bistre provided references. This meant that as in trials 1 and 2, better instruction (inform them clearly to provide credits, not just mention it in the Power Point presentation) should have been provided.

In the seventh lesson, students added final touches to their videos and exported the digital stories by uploading them as video files to the Google Drive © folders or by sending them to me via email. However, as discussed above, Absolute Zero wanted more time for editing and did not send their video by the end of lesson 7, and Bronze did not save it properly. These two groups were different from the low-achieving groups in trials 1 and 2 because there was no digital story to be marked; whereas the other low-achieving groups produced digital stories that did not fulfil the criteria.

In the eighth lesson, the students watched all the digital stories and engaged in a class discussion to exchange feedback on the outcomes and the process. 'Students were eager to watch each group's digital story and they seemed happy to explain the rationale of their decision-making while crafting the digital story'. I guided them into reflecting on whether they were satisfied with their work and how they managed problems. The discussion seemed to help them share openly reflections on their choices throughout the first and second stages. They reported that 'it was difficult to find the exact photographs they wanted' but 'building the characters and finding their voices was interesting'. They also talked about opportunities missed and answered to each other's questions about editing difficulties they had. The comments on the digital stories were in their majority encouraging. My understanding was that they were happy with how these turned out. The comments on the process were mostly positive and they seemed quite satisfied with the overall learning experience. All in all, I think the class screening and the discussion that followed run well and it is a valuable experience for reflection, peer- and self-evaluation. It provides an opportunity for them to externalise the newly



acquired knowledge, consider alternative avenues to problem-solving and learn from each other.

The averages of pre- and post-intervention student self-assessments of research skills (see figure 4.7) showed that there was significant improvement in their perceptions for all research skills competence levels with the most improvement observed in conceptualising and managing inquiry work, and data collection and analysis.

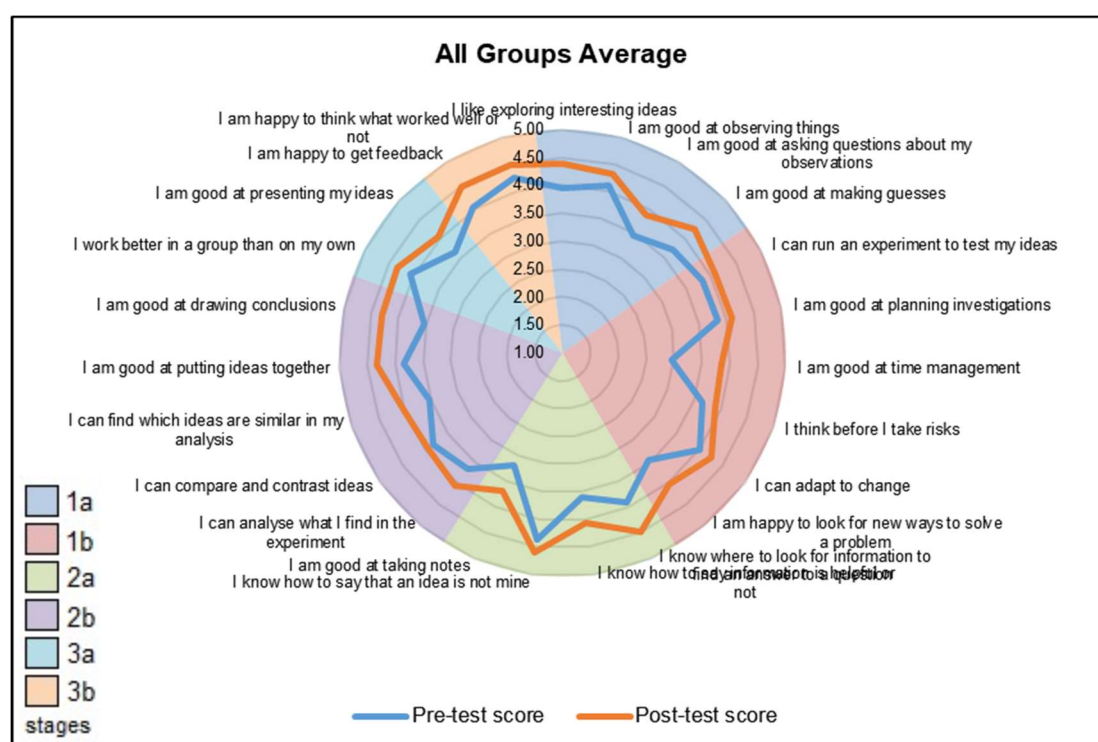


Figure 6.7: The averages of pre- and post-intervention student self-assessments of research skills.

As Azure put it ‘we learned how to do museum research’. Both high-achieving and low-achieving groups were able to apply prior knowledge of the inquiry process to conduct the web-based museum investigations and the majority of the groups managed to craft a digital story that presented the answers to the questions they had set. It seems that the inquiry process can include fictional elements just as the digital story can include evidential elements, but the interplay is non-linear. Half of the groups described the data collection and conceptualising the story each feeding into the other (‘as the story went on we

collected and took photographs from the museum database' (Absolute Zero)); and half of the groups gave priority to the digital story over the inquiry, and because they did not find the exact photographs that would match their needs either used external sources or adjusted their scripts accordingly or drew the illustrations themselves to communicate the intended messages. This meant that browsing for suitable information and visual content should be part of the planning stage just as re-drafting the script guided by the search results is part of the data collection.

### **6.2.2 A critical analysis of the emerging themes**

Similar themes emerge from the overall findings of the eight groups' learning experiences that confirm the symbiotic relationship between the inquiry-based and the digital storytelling learning processes and corroborate the findings of the first and second trials. The five themes are: 1. The type of research questions influenced the data collection; 2. The required flexibility with story planning during as well as after the data collection; 3. The use of other websites (beyond the digital collection); 4. The lack of historical information led to using their imagination; and 5. The need for technical training for the synthesis stage.

Below, I present each theme with a detailed description of a group's performance and I discuss how the new knowledge relates to existing knowledge in the literature.

#### **The type of research questions influenced the data collection**

Like in trials 1 and 2, the research questions each group set in lesson 1 had an impact on how they conducted their inquiries in the digital collection, which then influenced the plot development.

I use Begonia's performance as an example of this. Their digital story was about the mother-daughter relationship. They used a series of paintings and photographs, but their story was not based on true events. They came up with



the two fictional characters and an imaginary wedding taking place in 1844. The mother describes how lonely and desperate she feels now that her daughter is getting married and leaving her. Overwhelmed with negative emotions, she puts on her daughter's wedding dress and in her attempt to free herself from these emotions she tears it apart. She says:

I couldn't stop it. I started ripping the dress apart so that all my thoughts would go away. The moment the dress was thrown apart I fell to my knees and cried with lots of tears. I was looking at the thin silky fabric that was smooth as a roseleaf and I didn't know how to explain what I have done.

This extract showcases how they interpreted photographs of wedding dresses. By using a metaphor and strong imagery, they tried to depict information about material culture. In lesson 1 they used the hand-out to develop two research questions. These were 'What can the objects tell us about motherhood and marital life in the Victorian Era?' and 'What does the choice of the wedding dress really mean for the daughter and the mother?'. In hindsight, they explained that focusing their inquiry was helpful because '[o]therwise we wouldn't know what to search for. There are so many things that we could search for, we would be lost'.

In lesson 2 they did not really use the storyboard because they said, 'we just wrote the script on paper'. They chose the first-person point-of-view and in their drafted script -without including information on audio-visual effects- they laid out how they could showcase the mother's feelings of alienation and despair. For example, they wrote:

I stayed up all night. Thinking of what will happen to me when my daughter goes away. [...] A few days passed by and I still couldn't imagine how my life would be like after the wedding. The wedding day was here. Everybody was joyful, the place was blooming, and you could see serenity in each face. Who would have guessed what my smile was truly about?

This excerpt aims to expose the character's insecurity and inner thoughts about the state of her marriage. There is a gentle commentary on hypocrisy

and society's expectations of a mother in this 'joyful' position, thereby putting forward their interpretation of motherhood at that time.

In lesson 3 they used the laptop and the smartphone to access the digital collection of the museum, type in keywords such as 'wedding dresses' and look for photographs. Begonia members were captured in at least one photograph engaged in close looking at the photographs, downloading photographs, reading and writing text on the storyboard (see figure 6.8).



(a)



(b)



(c)



(d)



(e)



(f)

Figure 6.8: Begonia members (a) using the hand-out in lesson 1, (b) completing their storyboard in lesson 2, (c, d) searching the museum collection for suitable material in lessons 3 and 4, (e) writing their script in lesson 5, and (f) producing parts of their digital story in lesson 6.

The observation data showed that they were highly engaged and able to locate, collect and organise information (see figure 6.9).

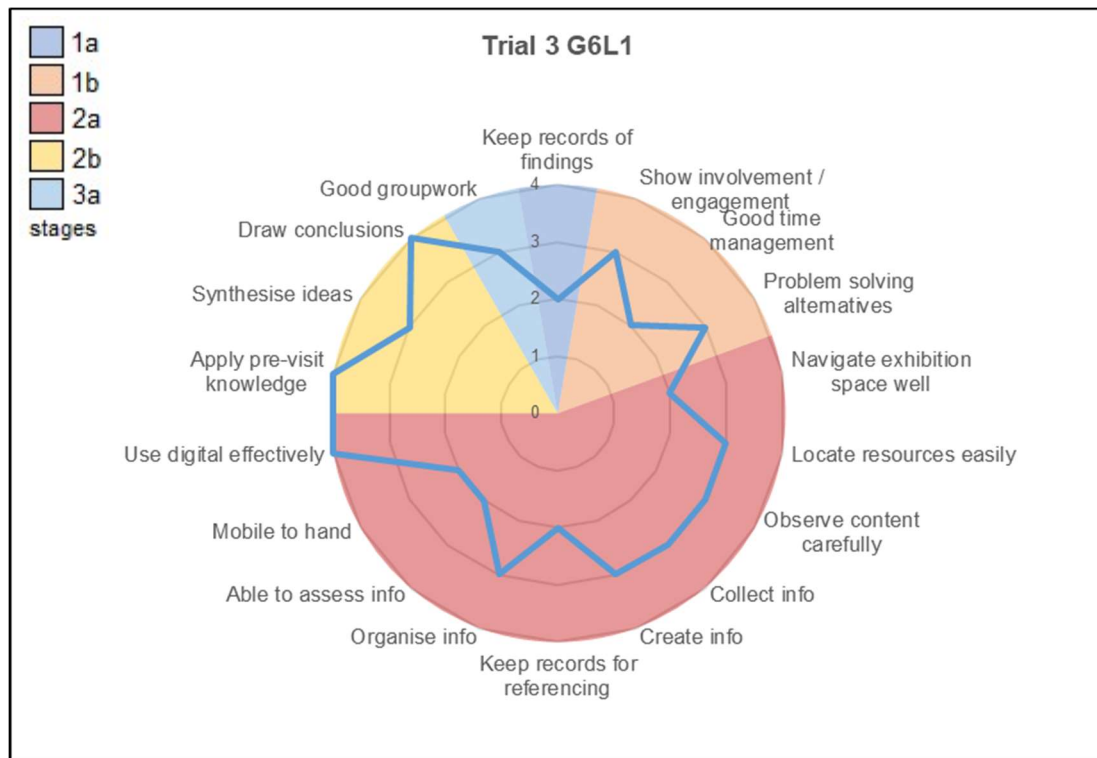


Figure 6.9: The Begonia group's observation data (L3).

As one student put it, 'we searched basically what we wanted to search'. For Begonia close looking at the photographs and taking notes were the most useful activities. However, this group also complained about the limited number of relevant photographs they could find but their experience differed from what other groups reported. Narrowing down their searches into clothes was not really problematic for them because in their case the digital collection had enough objects archived about clothes. This questions whether students' choice of topic should really be made after they familiarise themselves with the museum's website to get an idea of the collection and guide their choices based on the content that is available.

In lesson 4 their levels of engagement were kept high as they continued their data collection (see figure 6.10).

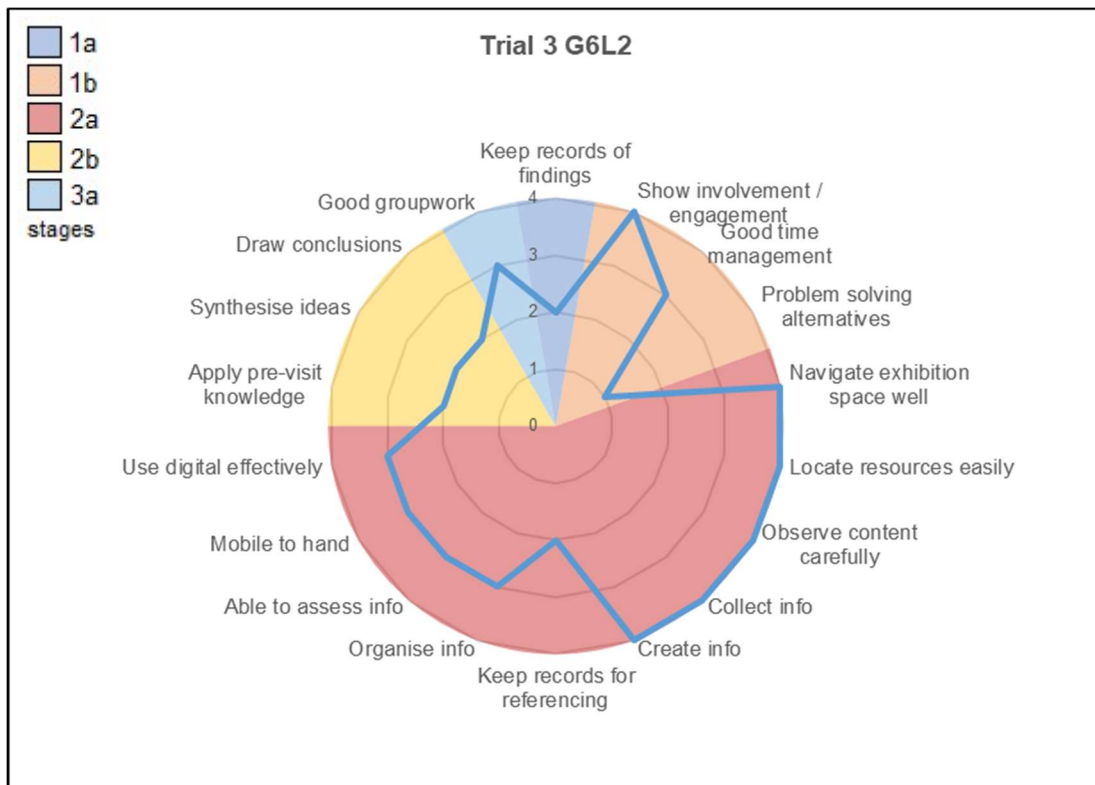


Figure 6.10: The Begonia group's observation data (L4).

They adjusted the writing to the search results ('the research helped us change a little bit the script and the tone of the story. [...] And make it better). Their digital story received an almost perfect score, i.e. 35,84 (see figure 6.11).

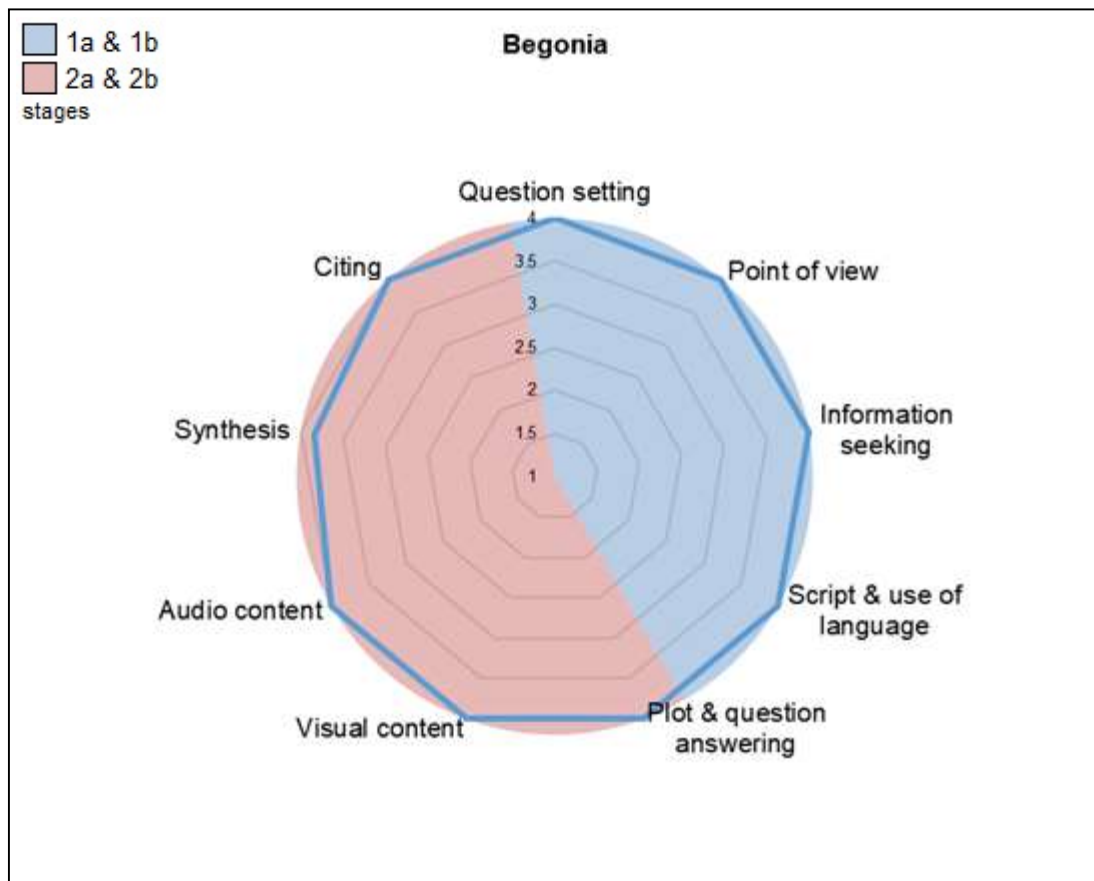


Figure 6.11: The Begonia group's digital story score.

In the fifth, sixth and seventh lessons, they used the i-Movie © software to produce their digital story. Once they finalised their script, they audio-recorded it on the smartphone and imported photographs, audio narration and music into the software to work on editing. They described the process as such: 'while we were listening to it, we were deciding where the photographs should go'.

This agrees with the literature (Kuhlthau et al., 2007; MacKenzie, 2016; Wolf and Laferriere, 2009) that reports that in open-ended inquiries the planning stage feeds into the data collection. What is new knowledge is that when digital storytelling frames such inquiries, students need to be flexible throughout the stages to adjust their story plans to the returned outcomes of their searches continuously. The triangulation of the findings of all three trials shows specifically the impact of the type of research questions on the mapping of the two processes (see section 7.2.1).

## **The required flexibility with story planning during as well as after the data collection**

In this trial it became clear that in order to contextualise the historical information retrieved from the digital collection, students had to make changes to their initial story ideas during as well as after the data collection.

The learning experience of Arylide Yellow shows why this was necessary. Their digital story was about child labour. They used a series of photographs and paintings for a story set in 1870 about the encounter between two fictional characters, a factory owner and an unidentified woman, mother of five, whose children also worked in the same factory. The narrator tells the story of a series of violent acts that took place during the woman's 12 hours long shift. The story ends with the woman being fired in her effort to protect one of her children from being physically abused. The plot is well-thought-out as the narrator begins by laying out the backdrop story and the dialogues follow describing the events. The script is clearly audio-recorded and visually the story is well-supported with a number of photographs, depicting women and young children operating machinery. In lesson 1 the group used the hand-out to keep notes about the types of information they would need to look for in order to expose what factory life meant for minors. They developed two research questions that guided their searches. These were 'What is the context of child labour in factories?' and 'What do we know about the operation of heavy-handed machinery?'.

In lesson 2 they came up with a storyline and used the storyboard to plan their digital story with the emotional intent to entice feelings of demise and despair. They drafted a script using third person point-of-view in their narrative with no information on audio-visual effects. The storyboard was not very useful because they had already decided the order of the events and the photographs they would like to have and 'with that order' they would start working directly on the script. In the questionnaires they reported that 'working on the script details' before the searches was the least useful activity because at that point they did not know 'what the script will be about', thereby indicating an awareness that it would be the findings of the museum inquiry that would

dictate the course of the story. Their approach to planning was to develop a basic storyline without yet developing the script. Their digital story scored high, getting a total score of 32,52 (see figure 6.12).

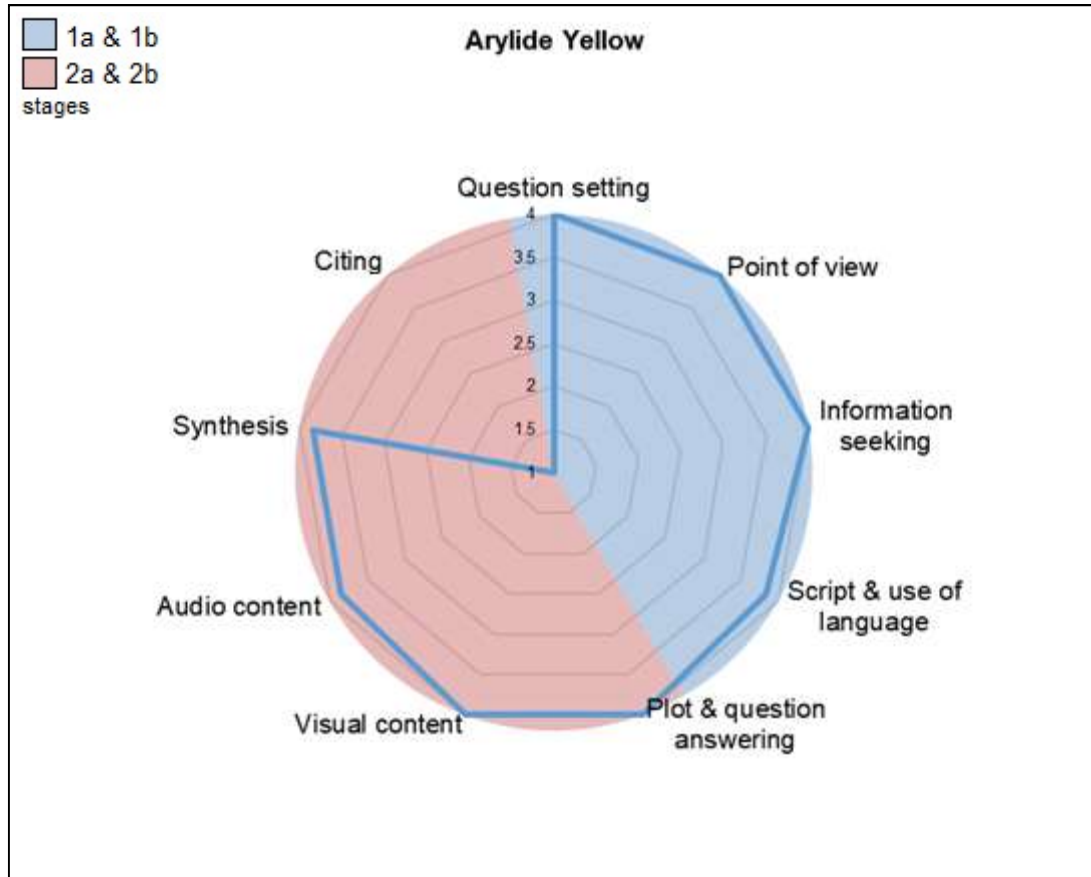


Figure 6.12: The Arylide Yellow group's digital story score.

They reported in the reflective interview that they were able to develop the script only after they saw the photographs and got 'an idea of what it is going to look like'. For example, they wrote in their script:

During the Victorian era most, lower classes were working in a factory. Factories were places where children were growing with machines, men and women were working for more than 12 hours non-stop. [...] Workers could lose their fingers in handling the heavy machinery or breathe the deadly chemicals that cause death. Conditions were harsh and payments were low.

This excerpt describes details that they were able to add only after looking at the collection materials to understand and visualise the working conditions.



Because after commencing the museum investigation they 'kind of got into the shoes of the owner and the people that were working in the factory' and that is when they could write the script. For Arylide Yellow the museum investigation was proper research to inform their creative writing.

In the third lesson they used their laptop to search the museum website for suitable material. According to the observation data, they demonstrated high levels of engagement in applying prior knowledge in the context, locating and collecting photographs (see figure 6.13).

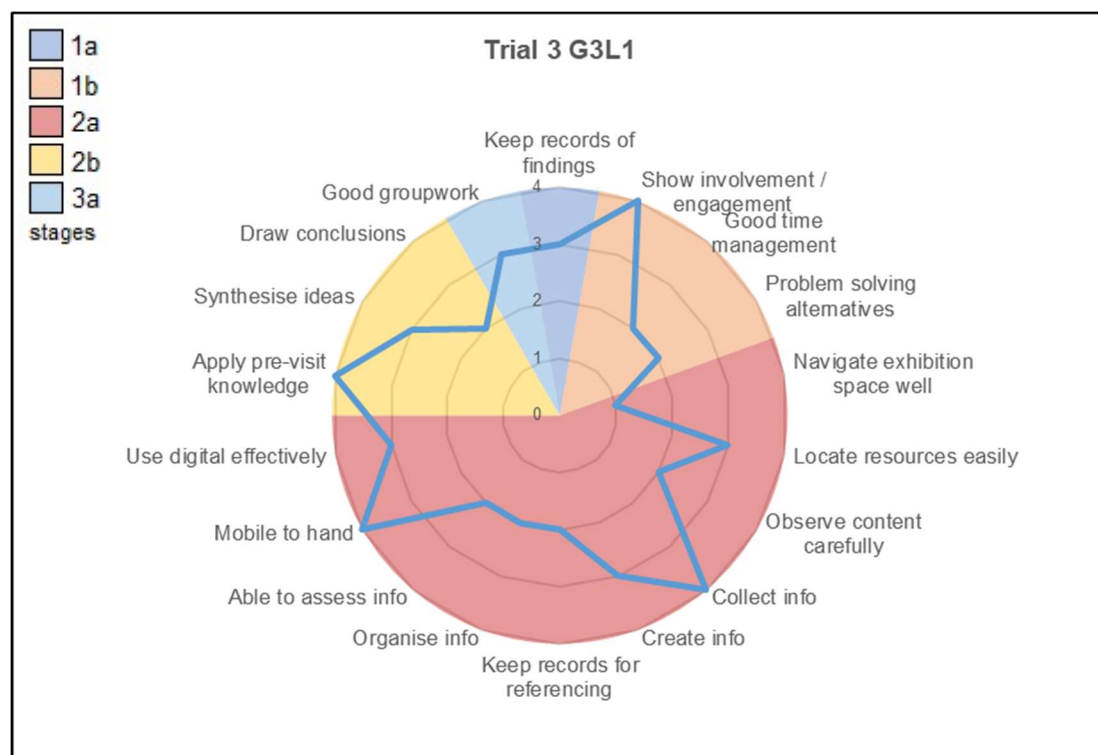


Figure 6.13: The Arylide Yellow group's observation data (L3).

They were seen in at least one photograph engaged in observing carefully the photographs that came up in the searches and downloading the ones they thought would best illustrate their story (see figure 6.15). However, as one student reported 'it was difficult to find photographs appropriate for our story [...] because the website didn't have all the photographs that we needed'. To tackle this, they decided to also use Pinterest © ('we were searching for the photographs that were about that time and we found some that were interesting, and we could use to illustrate our story'). The lack of suitable

photographs on the museum website is a recurring issue that raises a question about the degree of flexibility required to adapt the story plans to the search results. This group in particular demonstrated high flexibility and yet had trouble identifying suitable illustrative material. It is worthy of further exploration whether a preliminary search should be part of the story planning so that students adjust their inquiry and story plans accordingly.

In the fourth lesson they sustained their high levels of engagement in data collection (see figure 6.14) and dedicated time to observe the photographs ('close looking helped to get a better, detailed view of the object').

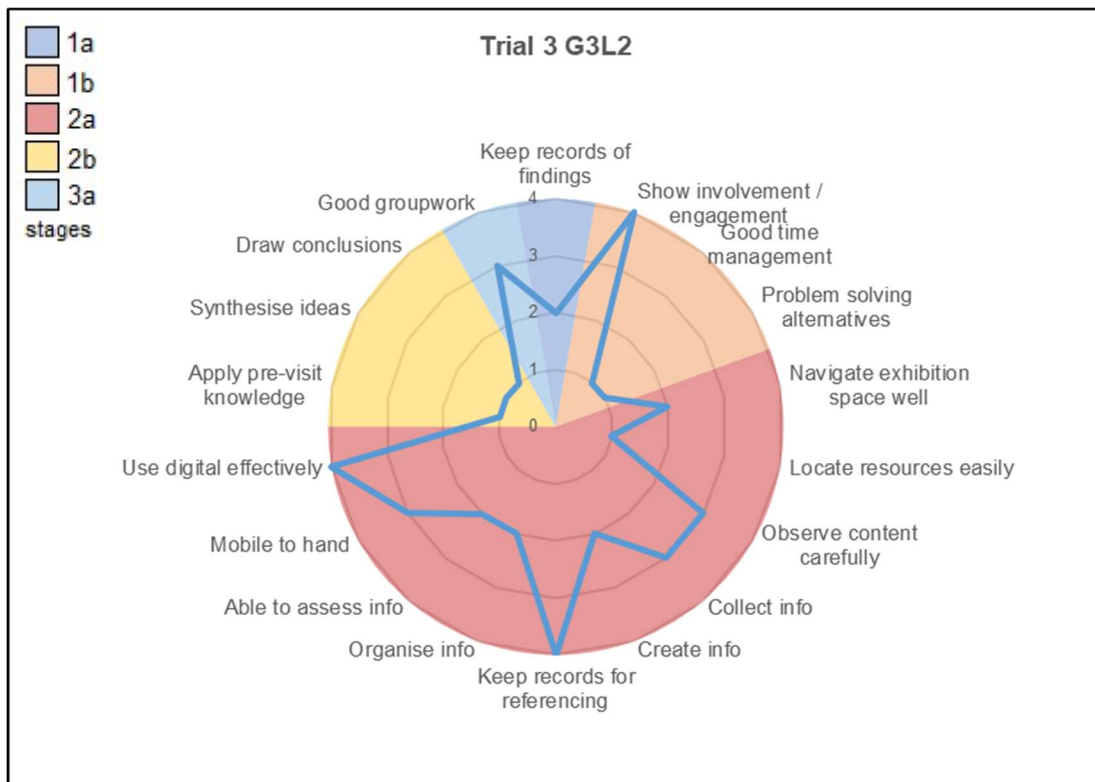


Figure 6.14: The Arylide Yellow group's observation data (L4).

As one student explained 'looking carefully at the museum database helped us because there were original things, but we should do it faster and not spend too much time browsing'. They returned to the storyboard to add information and as a result they altered the keywords they used for their searches, suggesting that the storytelling process guided them to refine their inquiry.



(a)



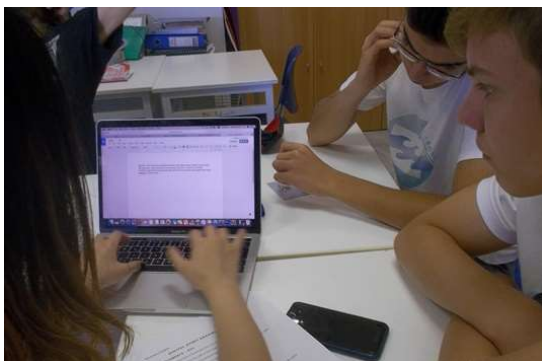
(b)



(c)



(d)



(e)



(f)

Figure 6.15: Arylide Yellow members (a) using the hand-out in lesson 1, (b) completing their storyboard in lesson 2, (c, d) searching the museum collection for suitable material in lessons 3 and 4, (e) writing their script in lesson 5, and (f) producing parts of their digital story in lesson 6.

In the fifth, sixth and seventh lessons they performed the analysis and synthesis of the story materials to produce their digital story using the i-Movie © software. They finalised the script, which they audio-recorded on a smartphone, and imported it into the software to synchronise it with the photographs. For Arylide Yellow, recording the script 'brought the story to life' and it was '[t]he most exciting part' of the story production even though they 'needed to repeat it a lot of times to get the perfect voice'. The story production did not run very smoothly because 'once we tried to edit and to make it better, it kind of got separated and we could not bring it back; so, we had to delete everything and put everything again inside i-Movie'. They had to start the synthesis again and spend more time on editing.

The way they made sense of the whole process was as follows:

In the beginning we just wrote some ideas down. But later on, we didn't use them because we found the photographs and we had some better ideas. Once we researched for the photographs, we had an idea of what is going on in our story. [...] Because once you do the research you know like what you have collected, and the questions are clear. And you know what you should make with your script.

Similarly, the learning experience of Alloy Orange shows why students had to adjust their story plans to the returned results from another perspective. Their digital story was about a fictional feminist uprising. They used a series of paintings and ceramics to illustrate a story inspired by Emily Bronte, about a young woman (Amy Bronson) who rebelled against society's unfair treatment of women and inspired others to rebel with her. The story ends with Amy tragically taking her own life in order to protect her comrades, when the government goes after them. Amy's feminist story is narrated by a male member of the group with key lines delivered by a female member in the role of Amy. The story has a well-structured plot enriched with a variety of photographs and a clearly audio-recorded script that communicates the answers to the questions the students had set. In the first lesson Alloy Orange used the hand-out to develop two research questions to construct the life of the leader of the fictional Bronson revolution. These were 'What can we find

out about women in Victorian Era?’ and ‘How do objects that portray women reflect the culture at the time?’.

In the second lesson, having chosen the emotional intent to entice feelings of determination and hope, they planned their digital story on the storyboard using third-person point-of-view in their narrative and drafting the script. Even though they did not think about the audio-visual effects at this stage, they said that the storyboard helped them focus their inquiry because they ‘knew how to start and where [they] were going to get’. Planning for the story made the inquiry easier for them because ‘we understood what we’re looking for. [...] Because we knew what kind of words to use to, like, look into our site’. For example, they typed in the search bar keywords like ‘women and revolution in England’, ‘women in Victorian Era’ or ‘revolution in Victorian Era’, which were linked with their questions. This performance was reflected in the almost perfect score their digital story achieved, i.e. 32,84 (see figure 6.16).

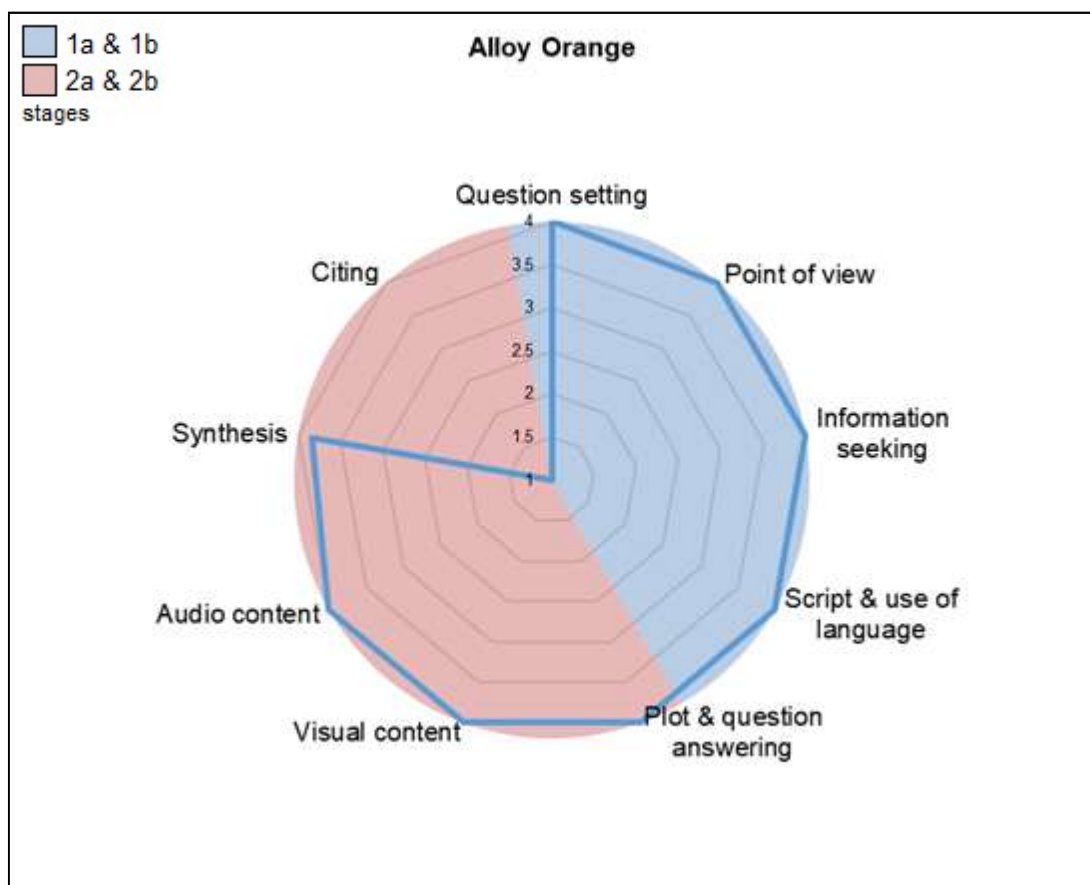


Figure 6.16: The Alloy Orange group’s digital story score.

In lesson 3 they exhibited high levels of engagement with the museum investigation and they performed well in navigating the website, locating, collecting, creating and organising story materials (see figure 6.17).

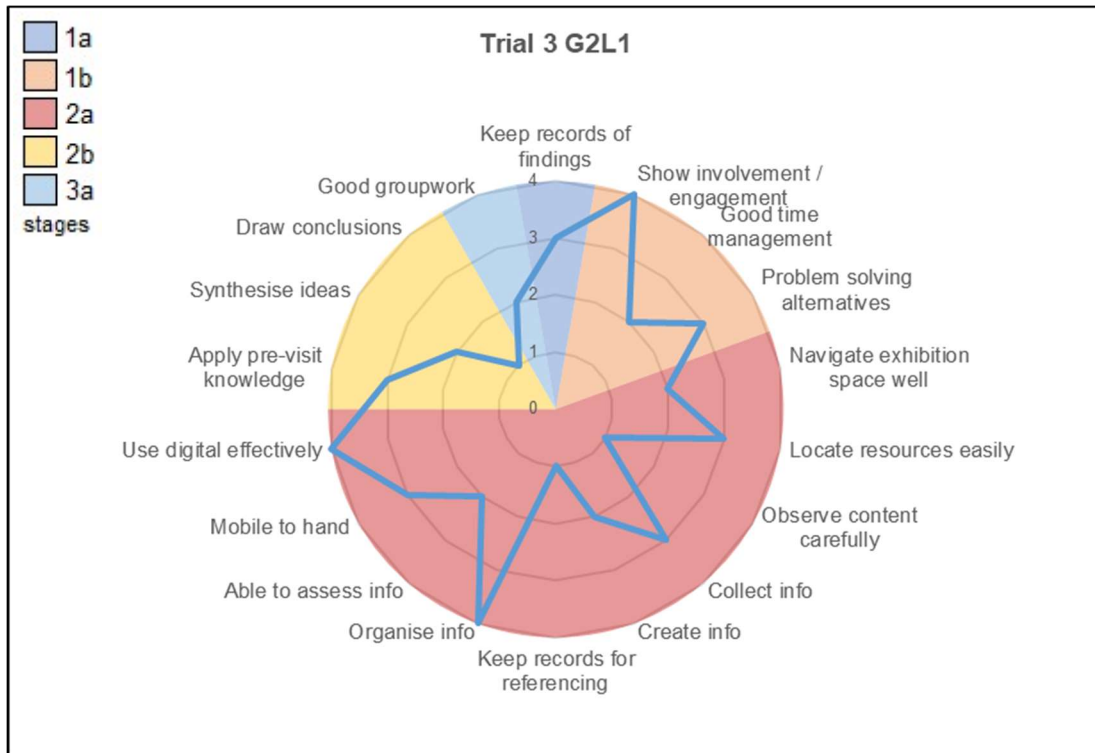


Figure 6.17: The Alloy Orange group's observation data (L3).

They said that using keywords to look for information and images of objects 'was pretty simple' because they had already decided the fictional events they were going to write about. However, when they started looking for photographs in the digital collection that would match their topic, the process was not straightforward. They were unable to find all the visual content that they wanted and as a result 'there were obviously some things missing'.

Faced with difficulties in mapping the search results to the storyline, Alloy Orange tackled this by using their imagination to fill-in the gaps in the historical information. For example, they wrote:

That night, Amy left and waited until the morning in the popular square of the city, where she had organised what would have been the beginning of a new revolution, even though she did not know it yet. In the morning, as the protest started, many kept joining, until hundreds covered the



streets of the city. A big revolution begins, and Amy does not understand she is putting herself in big danger.

This excerpt shows how they used historical information to embellish their character's life. By typing 'revolution' in the search bar they found the poster entitled 'women's liberation is the revolution' (ca. 1974). Filtering the search by typing 'Victorian Era' brought up photographs of public places such as squares, fountains and churches. My interpretation of this behaviour is that they tried to envision how their events would have unfolded in these settings.

In the fourth lesson they used the mobile devices effectively to do more keyword searches, look at the photographs closely, read about them and download the ones that were relevant to their story (see figure 6.18).

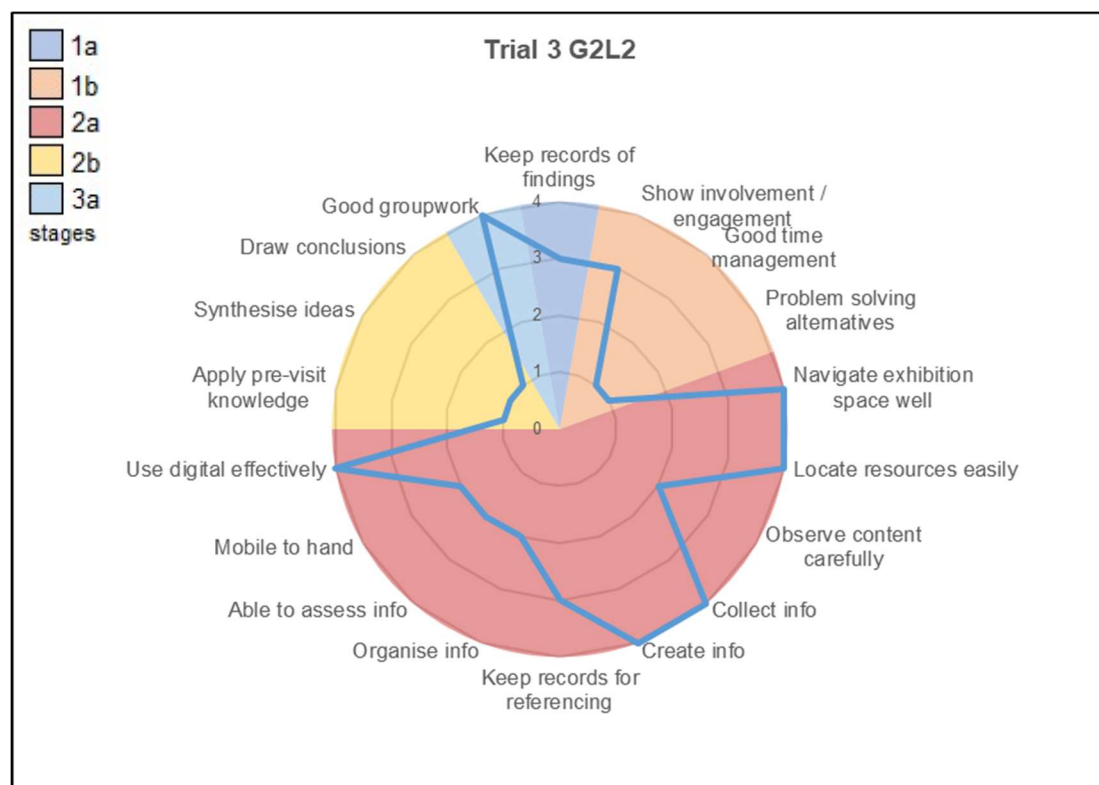


Figure 6.18: The Alloy Orange group's observation data (L4).

They said that they found 'most of the things' they needed. At the same time, they were taking notes on their storyboard, which they used to develop the final version of the script. One student said that 'our notes for the script about the objects helped us see how the whole story would look like even though we

did not use them all', suggesting that, at this point, the museum collection guided the conceptualising of the digital story. The final version of the script was developed after their museum inquiry was completed (see figure 6.19 (e)).



(a)



(b)



(c)



(d)



(e)



(f)

Figure 6.19: Alloy Orange members (a) using the hand-out in lesson 1, (b) completing their storyboard in lesson 2, (c, d) searching the museum collection



for suitable material in lessons 3 and 4, (e) writing their script in lesson 5, and (f) producing parts of their digital story in lesson 6.

In the post-visit lessons Alloy Orange synthesised the story materials using the i-Movie © software. They sequenced the photographs that they wanted to use, audio-recorded the script and edited the video. Knowing that they had faced challenges in finding photographs that would fit the script, I was also told that it was difficult for them to select relevant photographs and ‘to match them with the recorded voice’. They wanted to have enough photographs to illustrate the events in the plot. This group’s experience highlights how the editing process brings the museum inquiry and the digital story crafting together. On the one hand, exploring the museum content and reading about the objects inspired them to embellish their script with facts. On the other hand, when they could not find the photographs they needed for their illustrative purposes, the script was responsible to communicate the intended messages. They completed the digital story without finding all the photographs they were looking for. They ‘had to make the photographs last a bit longer’ because the recording was longer.

The following extracts from the group’s reflective interview outline the process they went through:

- [F]irst we wrote kind of a rough script and we decided what we were going to write.
- We just searched the key terms that we wanted on the museum website and then we looked through the pictures and found the ones that match with our topic.
- And we made sure that if it was a photo it was from the Victorian period but some of them were just illustrations, which were made later on. [...] The website didn’t have many pictures on our topic. But it was still pretty easy to find ones that would fit in.
- We had to have enough photographs. [...] Because the recording was a little bit too long. It was a lot of words. So, we ended up with a recording with which we had to make the photographs last longer.
- Like all the process that we went through helped us to understand, to develop ideas to put in our script and in our analysis and in our

presentation. Basically, we just connected all this stuff we got and made it a final video.

- The most useful activity I think was the research itself. [...] That's where we actually learned how to research things on the Internet and what museum sites to use.

These extracts show the group's effort to manage the museum investigation and problem-solve to complete their digital story. It seems that the inquiry process can include fictional elements just as the digital story can include evidential elements, but the interplay is non-linear. As one student said, 'I kind of learned better how to do it' and 'with practice, it could be even better'.

This insight is aligned with the literature (Calkins, 1984; Miller, 2010), reporting that script and plot development require revisits and inferring what is needed to advance the story and what is not. Also, it confirms that in the synthesis stage students use their critical and creative thinking skills (Boase, 2008; Czarnecki, 2009b) as they make informed decisions about manipulating the combinations of the story elements.

### **The use of other websites (beyond the digital collection)**

There were groups that either used or said that they would have liked to use other websites to collect photographs and information. According to Ohler (2013), story materials are not single-sourced. When a digital story is the outcome of a web-based museum inquiry, this means that access to the digital collection is not the only way of retrieving information as students may consult other archives and databases online.

I used Beau Blue as an example. In the first lesson they used the hand-out to develop two research questions. These were 'Are there objects to show what factory life meant for the owner?' and 'How do the objects expand our knowledge of the context and the period?'. They wanted to expose the peculiarities of being a wealthy businessman and to unfold the personality of such a person through an encounter between two fictional characters, the owner (George Smith) who was born in a noble and privileged family, part of a

‘trusted circle’ of the royal family, and his secretary (Ms Pauline). To do so, they imagined a revolt inside the factory. The story ends with the employees attacking the owner and him being unable to save himself. He says:

The situation got out of hand and I could hear the guards shooting. I peeked through the window and I saw that the whole street was attacking my guards. I now stand in my office knowing that I am living my last day. Outside my office is a wild mob ready to get some vengeance. It is not the money that they seek to get now. It is me they want. They want me dead. I don’t deserve this fate.

With this ending, Beau Blue tried to portray how they imagined factory life to be like for the owners at that time. Their intent was to entice feelings of despair and fear of protest. But they did not allow any sympathy for his faith because they made sure all the facets of his personality were depicted. They used the role of the secretary to show that the owner was a self-centred, alcoholic and abusive employer, and the one to be blamed for what followed.

They devoted lesson 2 mostly to drafting the profile of the owner using the first-person point-of-view and no information on audio-visual effects. They said that ‘we hadn’t built up the script yet like it was just the beginning of the script [...] we hadn’t developed it yet. [...] Later on, we just went on Google Docs © and we did the full script there’. This meant that, like Arylide Yellow, they were able to develop the script and their plot only after commencing the data collection. The almost perfect total score their digital story achieved, i.e. 35,68, suggested that their planning was successful (see figure 6.20).

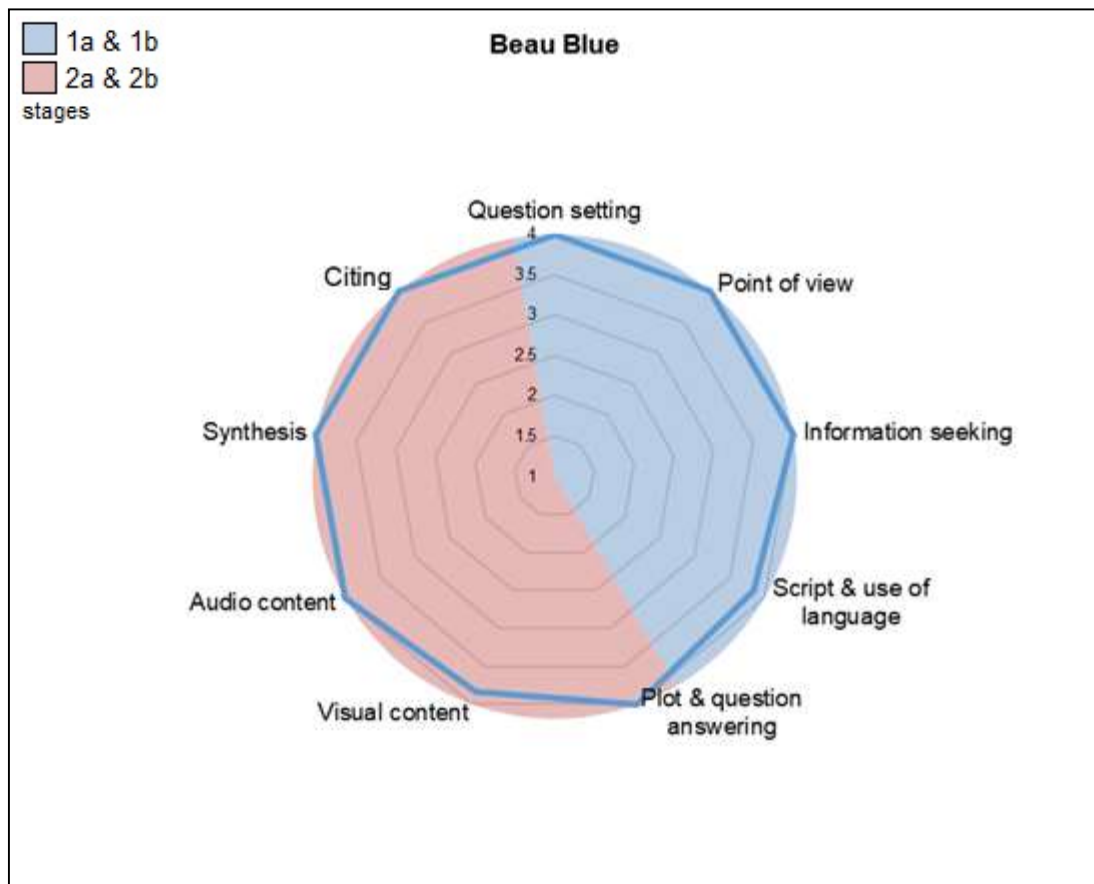


Figure 6.20: The Beau Blue group's digital story score.

In lesson 3, they used the laptop to access the digital collection and used keywords such as 'Victorian England' and 'wealthy factory owner'. They were able to navigate the website, locate information and assess its relevance, and create story materials (see figure 6.21).

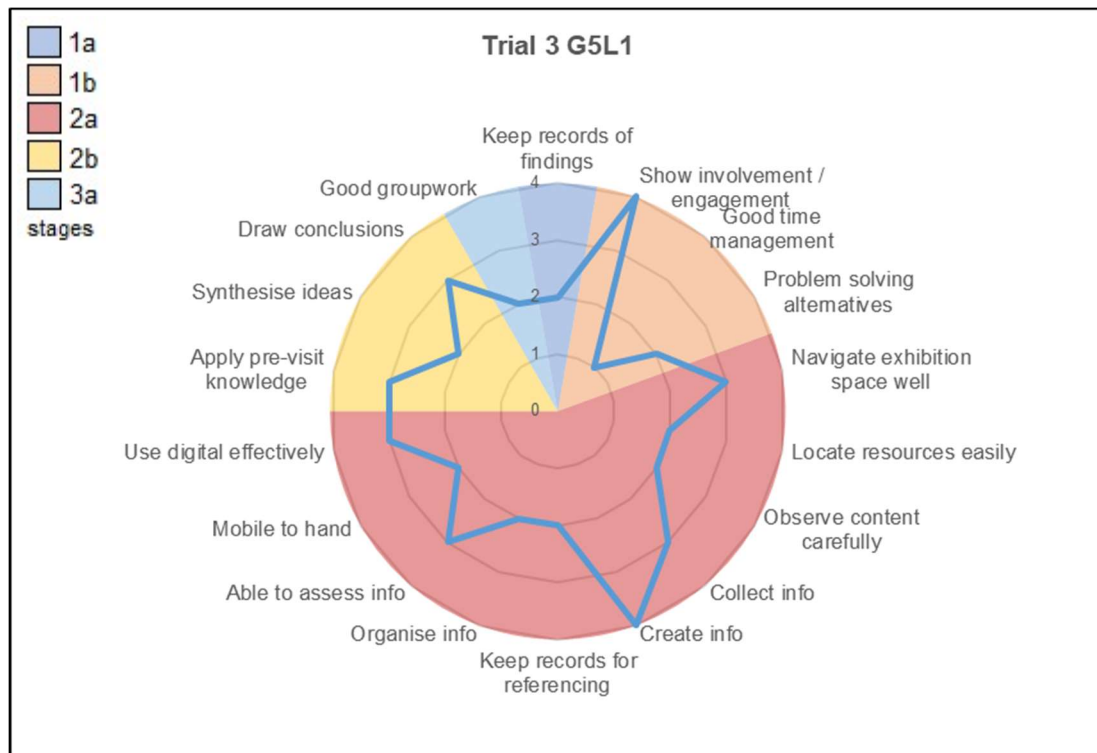


Figure 6.21: The Beau Blue group's observation data (L3).

They were seen in at least one photograph engaged in close looking at the photographs, downloading photographs and taking notes on the storyboard (see figure 6.23). However, they also said that '[t]he most difficult part was searching for specific photographs that were important or complementary to our story'. One interesting comment from a member of this group was:

The only thing that we did is find the photographs and we just tried to find the actual dates and events of uprisings of workers in factories. But that just didn't happen. So, we just made stuff up.

They used a series of paintings and photographs of real factories to illustrate the events, but they had chosen a very specific perspective and it was difficult to find relevant visual content that would accurately depict the encounter between the owner and the secretary. Thus, they used external sources to find what they were looking for. They explained that:

The only external thing that we found because we weren't able to find [in the V&A website] was the Victorian England office like how it looked from the inside because in the museum they didn't have historical photographs of it. So, we found it on the Internet and cited it.

In the fourth lesson they navigated the website effectively, locating and collecting information as well as keeping references (see figure 6.22).

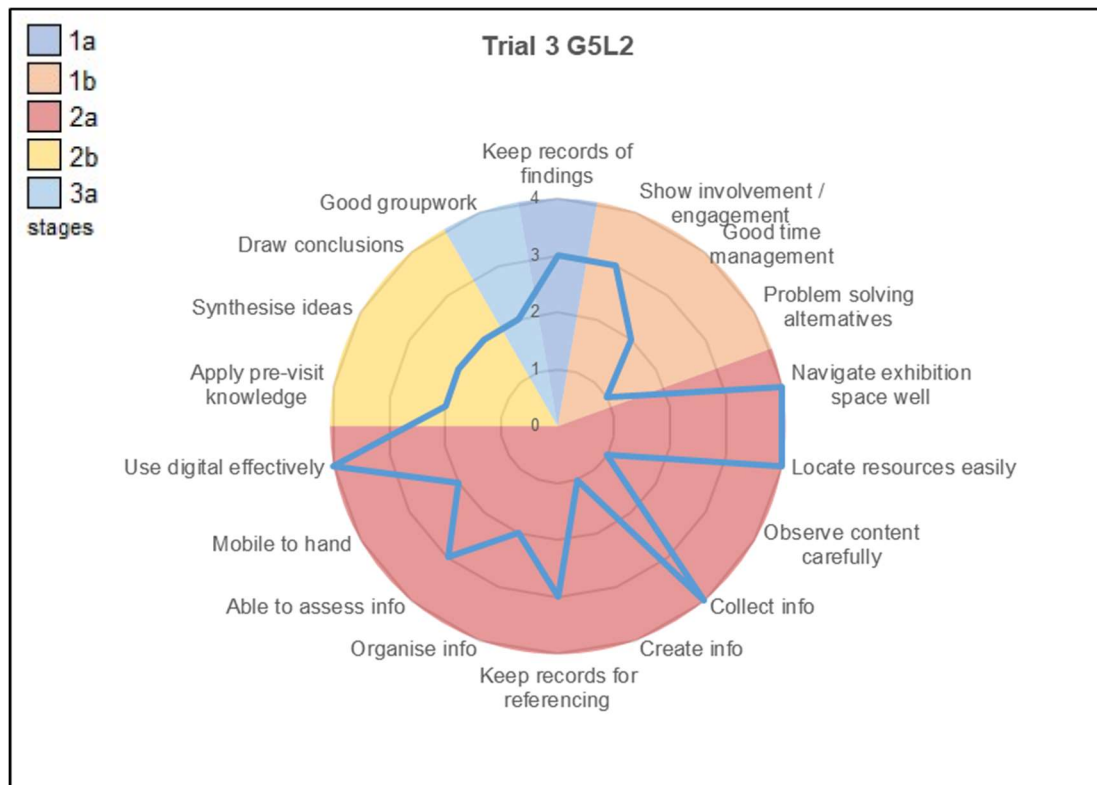


Figure 6.22: The Beau Blue group's observation data (L4).

They read the descriptions of the photographs, kept notes so that they could 'build up the story from those' and downloaded the photographs they thought were 'important or just complementary' (downloading the photographs and keeping notes were the most useful activities). At the same time, they were looking for audio elements to support their story even though 'it was just background music' (this was the least useful activity). They searched on YouTube © for songs that would complement the events, chose one that fit the purpose and downloaded it.



(a)



(b)



(c)



(d)



(e)



(f)

Figure 6.23: Beau Blue members (a) using the hand-out in lesson 1, (b) completing their storyboard in lesson 2, (c, d) searching the museum collection for suitable material in lessons 3 and 4, (e) writing their script in lesson 5, and (f) producing parts of their digital story in lesson 6.

In the post-visit lessons, Beau Blue used the i-Movie © software to put the story materials together and produce their digital story. They audio-recorded the final version of their script on the smartphone and described the story production as a creative process that ‘sparks [...] curiosity’. Overall, they seemed in control of the interplay between the inquiry and the digital storytelling processes, something they achieved by thinking ‘outside the box’.

### **The lack of historical information led to using their imagination**

It is interesting that, like in trial 2, the high-achieving groups dealt with the lack of relevant historical information by resorting in their creativity. They added and/or created fictional elements that complemented the collected information to suit their story plans.

Azure’s learning experience is an example of this. Their story was inspired by *Candida*, the protagonist in the same-titled comedy (1894) by George Bernard Shaw, who exposes Victorian notions of love and marriage, as *Candida* questions what is the social (and by extension the political) role of a woman at that time by debating with herself what she really desires from a husband. In that sense, this is another feminist story based on historical facts about the socio-cultural context that gave rise to the Suffragettes movement. But, just like the one Alloy Orange crafted, it is mainly fiction as it tells the story of the very first Suffragette, the unidentified leader of the movement. In lesson 1 they used the hand-out to develop two research questions about the context of the movement and how it begun. These were ‘What do the objects tell us about how women were treated and behaved at that time?’ and ‘How did the Suffragettes gain civic rights?’.

In the second lesson they developed a draft script on the storyboard without including information on audio-visual effects, using first-person point-of-view with which they intended to entice the viewers’ interest in the historical events and inspire further action. They found planning very useful because ‘we sort of planned it out before we did it, we just on a piece of paper did boxes with all



the scenes'. This performance was reflected in the almost perfect score their digital story achieved, i.e. 32,68 (see figure 6.24).

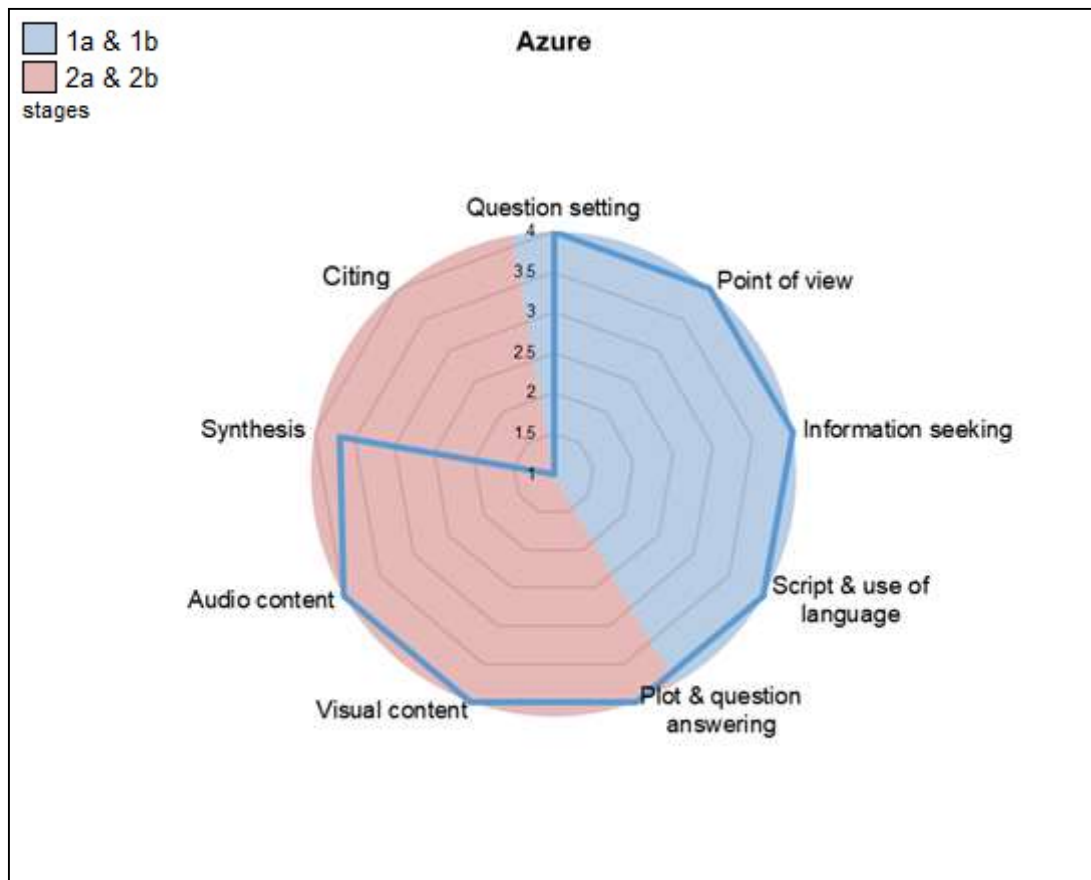


Figure 6.24: The Azure group's digital story score.

In the third lesson Azure members conducted parts of the museum investigation using a laptop and their smartphones to browse the museum website and collect relevant information. They were captured in at least one photograph using keywords in search of photographs, observing carefully the photographs that came up, reading their descriptions, downloading photographs and writing text on their storyboard ('[w]e typed in the keywords in the search box of the museum database and whatever came up, came up. And we chose the ones that were relevant to what we were talking about').

But they were not able to find all the photographs they wanted. So, 'we decided to create them ourselves'. Interestingly, they did not turn to other websites to

collect photographs. Instead, they decided to draw the illustrations themselves (e.g. see figure 6.25).

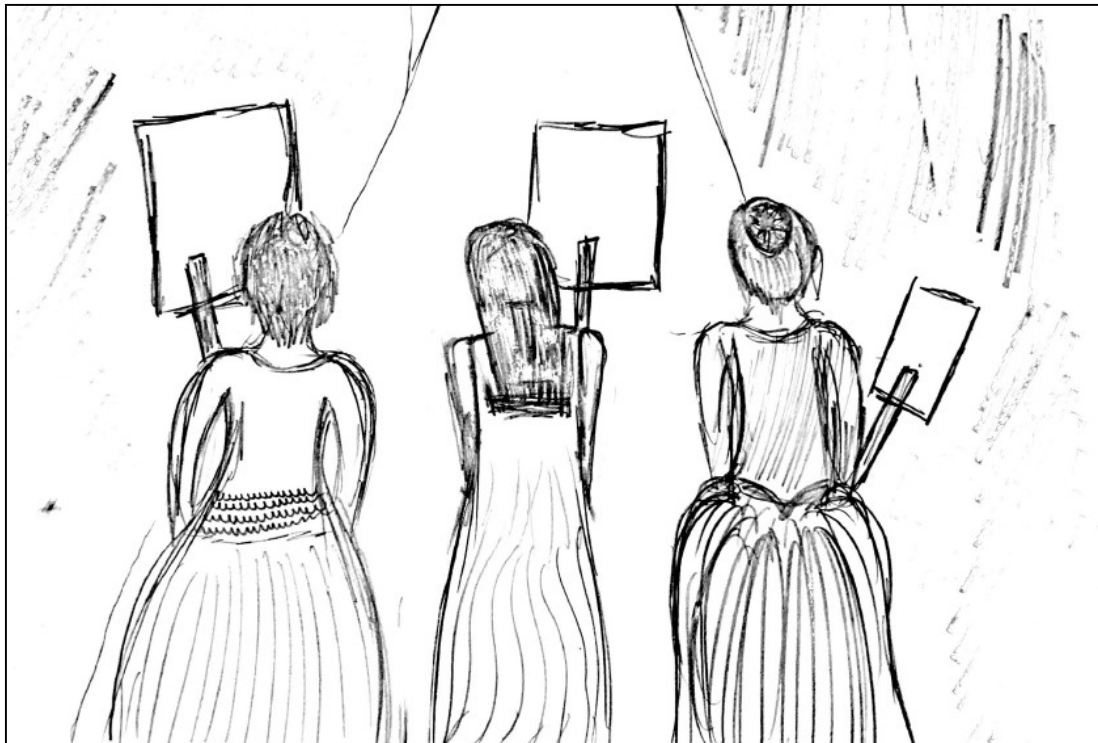


Figure 6.25: A sketch appearing in Azure's digital story.

One student volunteered to do the sketches of the pre-determined events and she produced twelve pencil drawings to better illustrate their digital story. It was also noted that they worked well as a group during data collection and generation, which they confirmed in their reflective interview by saying that '[w]e actually worked very well together. [...] Like much more than I expected us to'. Facing the challenge of not being able to find all the photographs they were aiming for, made them work together better than anticipated and use their creativity productively in order to complete the digital story. This insight aligns with the literature reporting that storytelling allows visitors to connect with collections in ways that are personally meaningful (Fisher and Twiss-Garrity, 2007) and communicate their internalised knowledge in an engaging way (Porter, 2005). That is possible because 'compelling stories reproduce the insight and experience of the storyteller' (Lambert, 2010: 14) and learning becomes 'centred on the learner and their experience, rather than [being] primarily content-driven' (Boase, 2008: 5).

Furthermore, the observation data showed that in lesson 3 they performed well in locating, collecting, creating, organising information and assessing its relevance as well as in record-keeping (see figure 6.26).

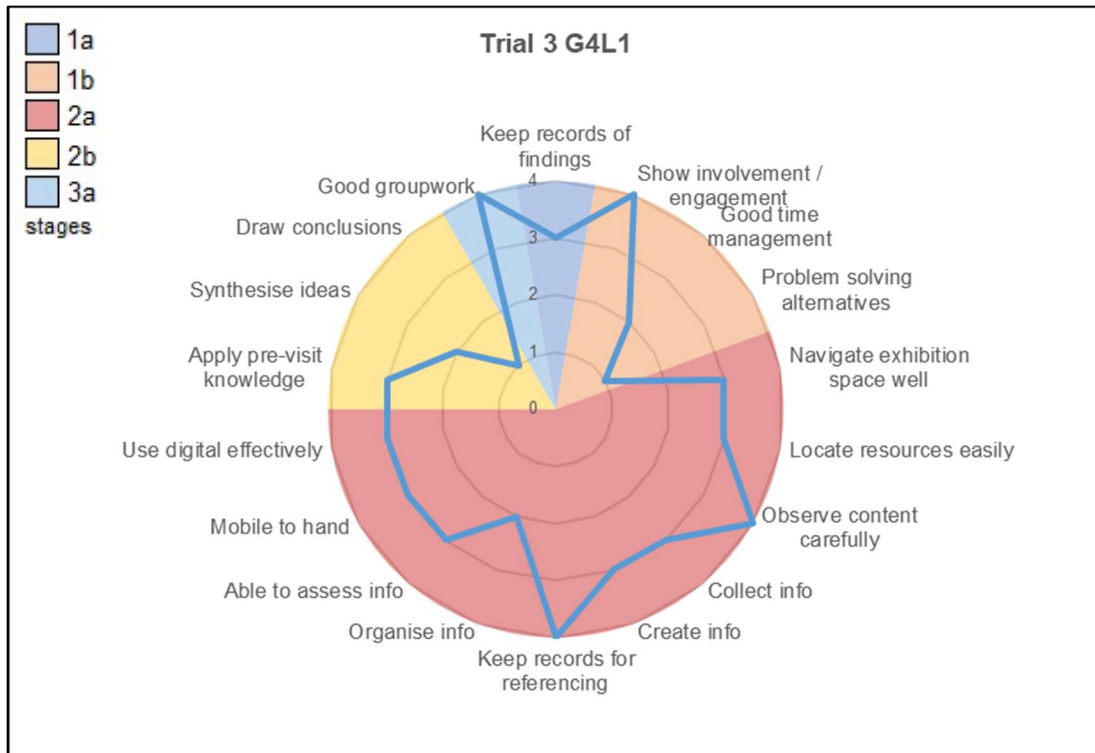


Figure 6.26: The Azure group's observation data (L3).

In the fourth lesson they completed the museum investigation by looking for more paintings and posters, reading the information available, downloading some photographs and working on their script (see figure 6.28). They performed better in using the mobile devices effectively to navigate the website, locating, collecting and creating story materials (see figure 6.27).

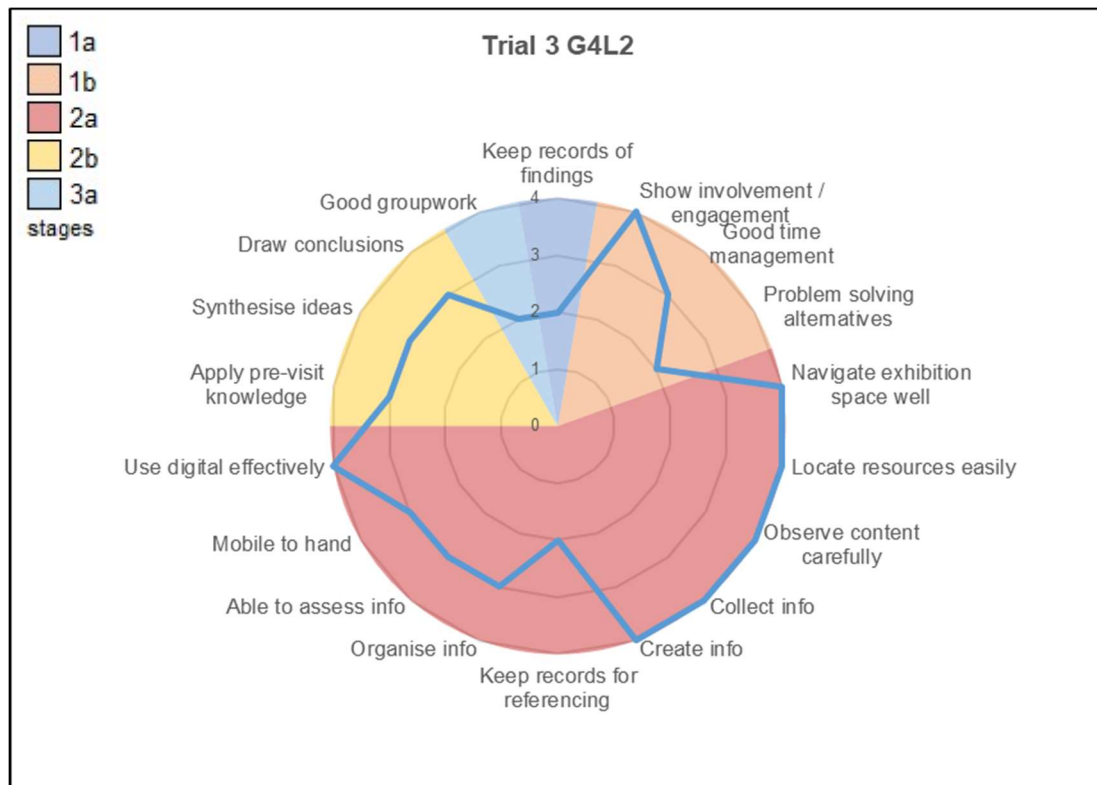


Figure 6.27: The Azure group's observation data (L4).

As one student said, 'reading the information and writing it were the most useful activities because that is where we got our information from'. Azure mixed historical information (photographs of paintings and posters) with imaginary information (their own sketches) to illustrate their digital story. They described this process as 'very creative' because '[w]e didn't like base it on one hundred percent true events that occurred then. We kind of just did our own story'.



(a)



(b)



(c)



(d)



(e)



(f)

Figure 6.28: Azure members (a) using the hand-out in lesson 1, (b) completing their storyboard in lesson 2, (c, d) searching the museum collection for suitable material in lessons 3 and 4, (e) writing their script on a smartphone in lesson 5, and (f) partly producing their digital story in lesson 6.

In lessons 5, 6 and 7 Azure used the Movie-Maker © software to put together the story materials. They finalised and audio-recorded the script on their smartphone. They said that they enjoyed developing the final draft '[b]ecause

for the script we used some quotes that actual Suffragettes had said at the time'. For example, their character paraphrased Susan Brownell Anthony (1820-1906), who led the effort to secure women's suffrage in the United States by saying 'women must not depend upon the protection of men but must be taught to protect ourselves'. This plagiarising of historical figures and events made their story more believable, while demonstrating the full potential of fictionalising museum facts.

The following extracts from the group's reflective interview outline the process they went through:

- [T]he least exciting part I would say was just at the beginning. [...] [W]e were kind of lost. We were just thinking too inside the box, thinking that it should be based on true facts. But then we got it.
- Once we found out what we wanted to do and we all agreed on that, we looked for the photographs. We had it sorted. And we did the drawings to complete it.
- And because we didn't find the ones we wanted, we decided to create them ourselves.

These extracts show the group's effort to craft a digital story using authentic materials from the digital collection and at the same time satisfy their desire to fictionalise and enrich facts with imaginary information.

This aligns with the findings of the second trial and confirms that producing a digital story is a process that hones the imagination as that may well be 'the greatest benefit [...] when students are given the task of creating their own digital stories' (Robin, 2008: 224).

### **The need for technical training for the synthesis stage**

The final theme that came up was the need for technical training with respect to editing and synthesising the story materials to produce a video. Like some groups in the first and second trials, it appears that both high-achieving and low-achieving groups would have benefited from better scaffolding in manipulating the software features.

Bronze's learning experience is an example of this. In lesson 1 they used the hand-out to frame two research questions: 'Can the museum objects tell us anything about the role politicians had at that time?' and 'How do the objects' value reflect the social context and expand our knowledge of politics in the Victorian Era?'. They wanted to craft a detective story around four fictional characters (the leader of a Christian Socialist party named David McKomie, his assistant Timofey, his wife and a detective named Mr Swindon). Their story was about the rising and fall of the leader, who was betrayed and assassinated. Their intent was to entice the viewers' interest and curiosity about the politicians' role in society at that time.

In lesson 2 they worked on the storyboard to draft a storyline of events (a public speech before the elections and the assassination), which would be narrated in the first-person point-of-view without including information on audio-visual effects. They drafted in the script:

I cannot bear the burden of the death of our true leader. My best friend lost his job for investigating McKomie's assassination, which makes me question the future of Christian Socialism.

The text shows their intent to be critical of political aspirations and expose the complexities that gaining power involved. Bronze chose to give priority to the digital storytelling process over the inquiry process. They used prior knowledge about the rise of Christian Socialism (1848) as a reformist movement in England associated with cross-class communitarians combining the aims of Socialism with the religious and ethical convictions of Christianity, but they did not base their story on any real people or events of how the party dissolved in the mid-1850s.

In lesson 3 they used the laptop to access the digital collection, navigate the website, locate and collect story materials that would bring their story to life. The observation data showed that they were highly engaged in reading the interpretative texts of the objects that came up in their searches and in keeping records for references (see figure 6.29).

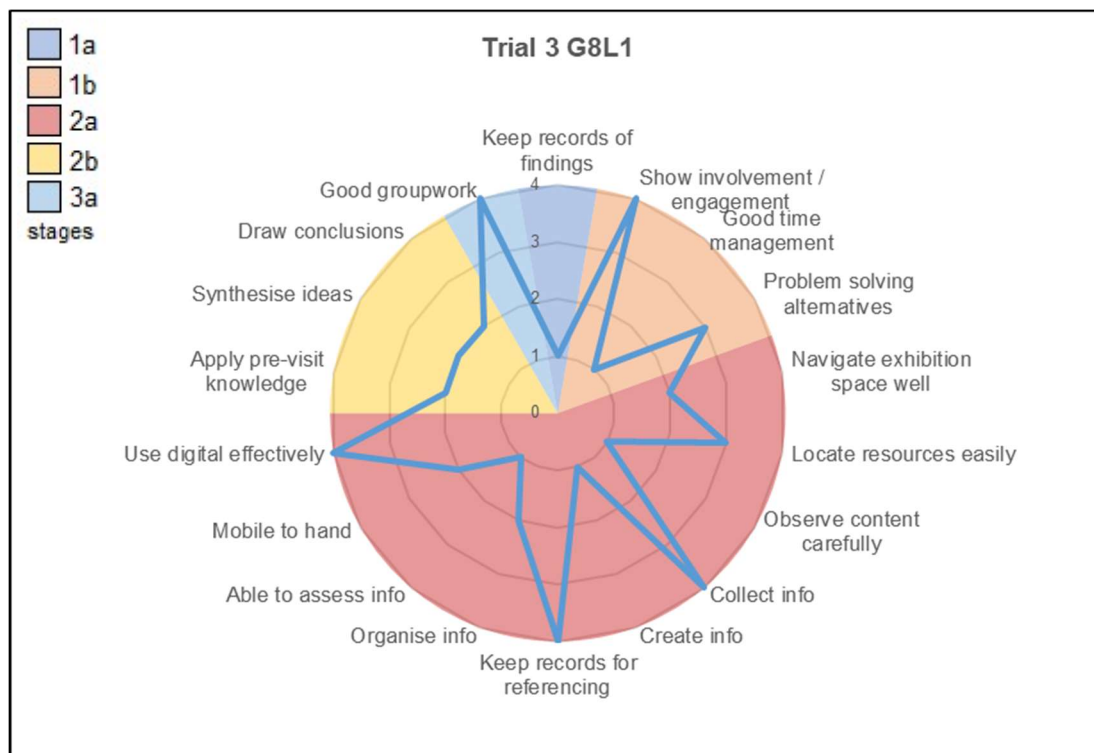


Figure 6.29: The Bronze group's observation data (L3).

They were captured in at least one photograph engaged in close looking at the photographs and note-taking on the storyboard (see figure 6.31). As one student reported in the questionnaire 'close looking and taking notes helped because I could remember things and details about them'. Even though their intent was not to use information about real people and events, they interpreted the museum content to consolidate their understanding of the topic and enrich their story.

They devoted lesson 4 mostly to data collection by doing more keyword searches and downloading relevant photographs as well as to exchanging feedback to analyse the collected information (see figure 6.30).



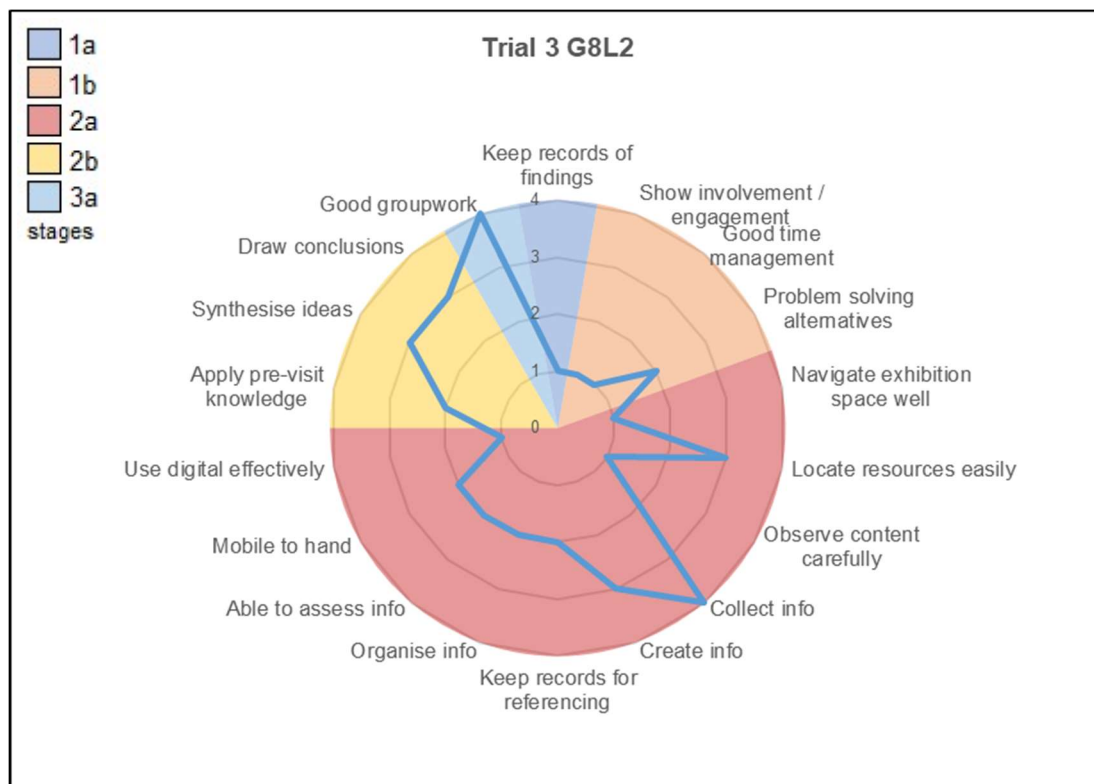
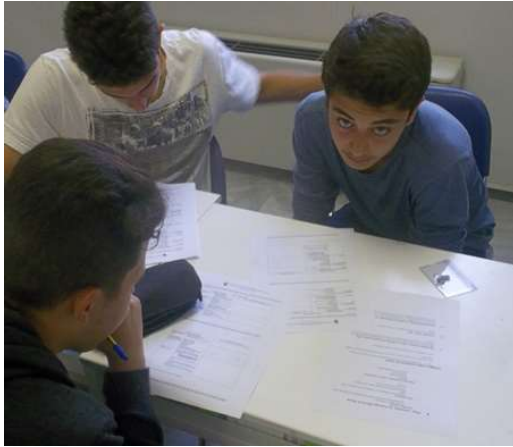


Figure 6.30: The Bronze group's observation data (L4).



(a)



(b)



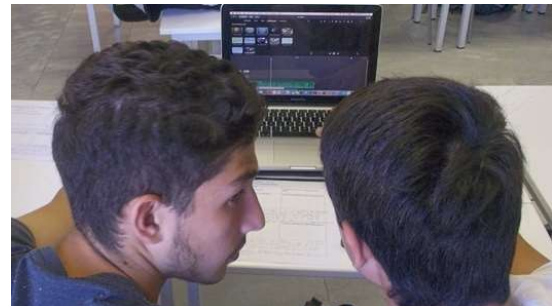
(c)



(d)



(e)



(f)

Figure 6.31: Bronze members (a) using the hand-out in lesson 1, (b) completing their storyboard in lesson 2, (c, d) searching the museum collection for suitable material in lessons 3 and 4, (e) writing their script in lesson 5, and (f) producing parts of their digital story in lesson 6.

In lessons 5, 6 and 7 Bronze members were captured in at least one photograph working on their script ('writing the script was the most useful activity because we could not really get into the body of a character by just

looking at the photographs'), which they audio-recorded on the smartphone and imported in the i-Movie © software alongside the photographs to produce their digital story. They revisited the website to download more photographs and embellish their story with more visual content.

Despite their evident engagement with the process, the group did not submit a digital story because the video was not saved properly. It seemed that they would have benefited from a demonstration or step-by-step training on how to export the video and upload it to their Google Drive © folder. This agrees with what Lambert (2010) stated about gaining familiarity with media grammar and obtaining basic understanding of the video composition tools. In other words, when designing a *DiStoMusInq* intervention, a teacher should provide time and resources in technical training and support.

### **6.2.3 Post-intervention teacher interview**

The interview with the teacher took place after the end of the intervention. The teacher (like teachers in trials 1 and 2) was present in each lesson but not involved in the design or delivery of the lessons. But like the role the chaperones had in the first and second trials, in lessons 3 and 4 she observed the students conducting the web-based museum investigations and filled-in the observation form. The interview aimed to elicit the teacher's insights on how successful the mapping of the digital storytelling onto the inquiry process was, addressing the limitations and eliciting suggestions for improving the *DiStoMusInq* framework.

The interview explored the teacher's inquiry-driven teaching practice in the English Literature subject. The teacher implements inquiry '[b]ecause, in the English classes, a big part of the teaching is about the socio-historical context in which the literary work was created' and the students have to research that context. Each student works independently on essay assignments based on literature units. For these assignments, the students engage in literary analysis of linguistic elements and themes and articulate their understandings in compositional writing. Through this process, students develop research skills

as they do library searches, take notes, outline and draft, revise and edit their essays. The process is akin to crafting a digital story (see section 2.2.2).

One notable difference from the intervention (noted in trial 1 too) is that for the essays, students work individually rather than in groups. The subject mark is based on three elements: the essay assessment, which awards marks for quality of composition and depth and quality of text analysis; the assessment of an oral presentation which awards marks for clarity and persuasiveness; and the assessment of class participation, which awards marks for collaboration and initiative. The intervention placed more emphasis on the collaborative element of the course, embedding it in a more organic way within the inquiry-digital storytelling process. Nevertheless, this was a new way of working for students.

The potential of digital storytelling to frame and facilitate inquiry-based learning in the context of an online museum visit was received positively by the teacher, who commented that 'the idea of using archival data to round out their stories is great' because the digital collection is 'such an incredibly rich resource'. She further explained that

I think they learned a lot more about the actual social period of the Victorian Era. I think especially the visual part was really interesting for them. I think that the visual part helped them conceptualise the social and political problems just by seeing, you know, artefacts, photographs.

The teacher's emphasis on the visual aspect of the collection highlights the connection with digital storytelling, which relies on the composition of audio-visual materials to communicate the intended meanings. But it also highlights the importance of analysing visual content such as photographs, portraits and drawings to understand and make sense of the historical and social context of the objects. In agreement with the literature, crafting a digital story was a way for students to read museum objects 'by giving them meaning, purpose and context' (Johnsson, 2006: 6). This exposes a synergy between the inquiry and the digital story processes that merge in closely looking at the photographs that come up in search results and manipulating them to represent the inquiry outcomes visually within a narrative frame.

Like Absolute Zero and Alloy Orange, the teacher also noted that not being able to visit the V&A in person was a limitation, as a physical visit would have given students direct access to the museum content they were reading about. According to her, a physical visit:

[W]ould be more exciting. But this was exciting in the sense that they had to research, they had another way of accessing the data and storing the data. You know, seeing something and talking to museum personnel is one way. But this way made them more independent learners. [...] So, I liked this approach.

She explained that the students 'got a little glimpse of how they are going to do, like, empirical data collection', thus indicating that she considered the museum-based inquiry as an authentic research task. The teacher's description of how students chose 'from the database [...] what [they] need[ed] to match the story' captures the inquiry-digital storytelling interplay and how it was facilitated by the exploration of the digital collection. She added that even though 'we didn't tap it enough [...] we just scratched the surface' and 'even if they didn't master it at least they got the idea, that there is a different way that research is done professionally'. This comment highlights the role of digital collection items as primary research sources.

The teacher had positive comments on the impact of the intervention on students' digital literacy, in particular regarding the use of mobile devices for learning and research: 'that was the biggest insight for them, that they could learn something new on how to use their technology'. However, she added that 'the editing part was a little hard for them, it was new, and it was a lot more involving that they thought it would be'. She suggested that teachers should have some training themselves first and reliable technical support to be able to support students in using the software. The teacher's comments echo those of the students in the reflective group interviews and the first trial findings.

When asked for her insight as to ways of improving the *DiStoMusInq* framework, the teacher gave the following suggestions. Firstly, she would have less time spent on presenting the inquiry-based learning process because students have prior knowledge; and before the second lesson she would have

assigned warm-up tasks to have them engaged with the sources before drafting the script:

[B]efore I asked them to make the story with the archival data from the museum database, I would give them another task. I'd make them make up a bibliography or I'd have them find five photographs and, you know, ask them to write a description.

And she would have set 'more specific requirements for the storyboard' because in the context of the English Literature curriculum, the writing of the script is an important element of the task. She explained that:

I listened to the scripts and they were clever. I mean some of them were clever, some weren't so clever, some were kind of you know in the middle. But I would work more on that part as a teacher.

These comments point towards the need to allocate time for scaffolding students' script and plot development with in-class writing drills in devising characters and a series of events that connect and blend facts with fiction.

Like in trials 1 and 2, difficulties faced with plot development impacted the content and quality of the audio narration and hence the scores the digital stories achieved in plot development and question answering. Therefore, apart from teaching students the practicalities of using the software and experimenting with transition effects for producing the video, students should be trained and given support with creative writing and fictionalising based on historical information for building a narrative with an explicit purpose and intent.

### **6.3 Summary**

The objectives of the third trial were to try out the refined instructional and data collection procedures in a different museum context where students conduct web-based museum investigations in the digital collection. The findings are highly informative because they illuminated how the symbiotic relationship between the two processes unfolds in the *DiStoMusInq* framework and showed how digital storytelling can frame successful museum investigations.

## Chapter Seven

### DISCUSSION

#### 7.1 Introduction

Chapter Seven draws upon the data across the three trials to illuminate how the students performed throughout the interventions and how digital storytelling framed successful museum inquiries. These insights are then applied to its refinement proposing a set of principles for its implementation. The benefits substantiate the *DiStoMusInq* framework's effectiveness and the study's contribution conceptually, practically and methodologically.

#### 7.2 Conceptual contributions

##### 7.2.1 How does a *DiStoMusInq* intervention work?

Conceptually, the research shows how the blending of the two processes work and what are the benefits of doing so (for self-initiated and self-directed museum learning and for research skills development). In this section, I present and try to explain how the interventions worked overall across trials, feeding back to the literature the identification, understanding and contextualisation of the synergies of the two processes.

The *DiStoMusInq* framework had students plan investigations based on questions of personal interest, then collect and analyse information to craft a digital story that presents the answers to their museum inquiries. Initially, the framework consisted of three stages organised linearly (see table 2.5), each describing a set of inquiry and storytelling activities for which students exercise similar skill sets.

<b>Inquiry</b>		<b><i>DiStoMusInq</i></b>	<b>Digital Storytelling</b>	
Stages	Skills	Stages	Skills	Stages
Questioning	Topic exploration and selection Question-setting	1a Conceptualise	Set a story idea Type selection Define purpose (dramatic question)	Planning
	Investigation planning	1b Plan and manage	Storyboarding Draft script	
Information gathering, analysis and inference	Information searching, selection, collection/creation	2a Data collection and generation	Information searching, selection, collection/creation	Production
	Information analysis, organisation, interpretation and synthesis	2b Analysis and synthesis	Information analysis, organisation, plot development and editing	
Reflection	Present Reflect/discuss	3a Sharing 3b Peer review and reflection	Share and watch Reflect/discuss	Reflection/Post-production

Table 2.5: The *DiStoMusInq* framework.

Student groups across trials applied prior knowledge of the inquiry process to conduct museum investigations and the majority (fifteen out of twenty-three) of the groups that submitted a digital story managed to craft a digital story that answered the questions they had set. The following insights from across the trials are set to the fore to describe how the students performed throughout the interventions in each stage.

### **Stage 1: Conceptualise, plan and manage the museum investigation**

In the first stage, students engage in inquiry and story planning activities. They form research questions based on the general information given about the museum content and they develop a story idea using the storyboard and draft their scripts. To conceptualise their group inquiry and story, they exercise research, visual arts and language arts skills such as observing, reading, writing for different purposes, listening and speaking. The questionnaire data showed significant improvements in all three trials in students' self-perceptions of competence levels for research skills related to the first stage. The analysis showed that the way students worked in this stage influenced their work in subsequent stages. The level of planning done pre-visit impacted the data collection because the research questions guided the museum investigation,



and the amount of work put in drafting the script facilitated the plot development in the second stage.

Nearly all groups used the hand-out, and many consulted the prompting questions to form their own research questions. Particularly, they were keen to ask their own questions driven by their curiosity and, in the case of trial 3, driven by interests developed during earlier parts of the course. This aligns with what the literature says about the value of setting personally meaningful questions (Buckner and Kim, 2014). The intended role of the hand-out was to support students in developing a focus by activating prior knowledge of the inquiry process and making suggestions how to articulate that focus. The pre-intervention interview with the teacher in the first trial showed that using the hand-out aligned with how she provided scaffolding in teaching Art History; and although the students themselves did not comment on the usability of the hand-out, I noticed them actively using it in the lessons to support their work. Similarly, in the second and third trials, students from mid-achieving and high-achieving groups (Alabama Crimson 2, Artichoke, Azure and Begonia) said that the hand-out gave them focus ('there are so many things that we could search for, we would be lost' (Begonia), and helped them think of what was important to know ('[it] helped because we knew what to look for' (Alabama Crimson 2)). Whereas students from low-achieving groups tended to find it less useful (Brass and Burgundy).

A closer look at the types of questions students set for their inquiries reveals two broad categories: functional questions, which related to the museum objects' function, construction and properties; and contextual questions, which related to people and the historical, socio-political contexts in which the museum objects were used. Across the three trials, eleven groups had mixed questions (one functional and one contextual), four groups had two functional only, and eight groups had two contextual questions only (see figure 7.1).

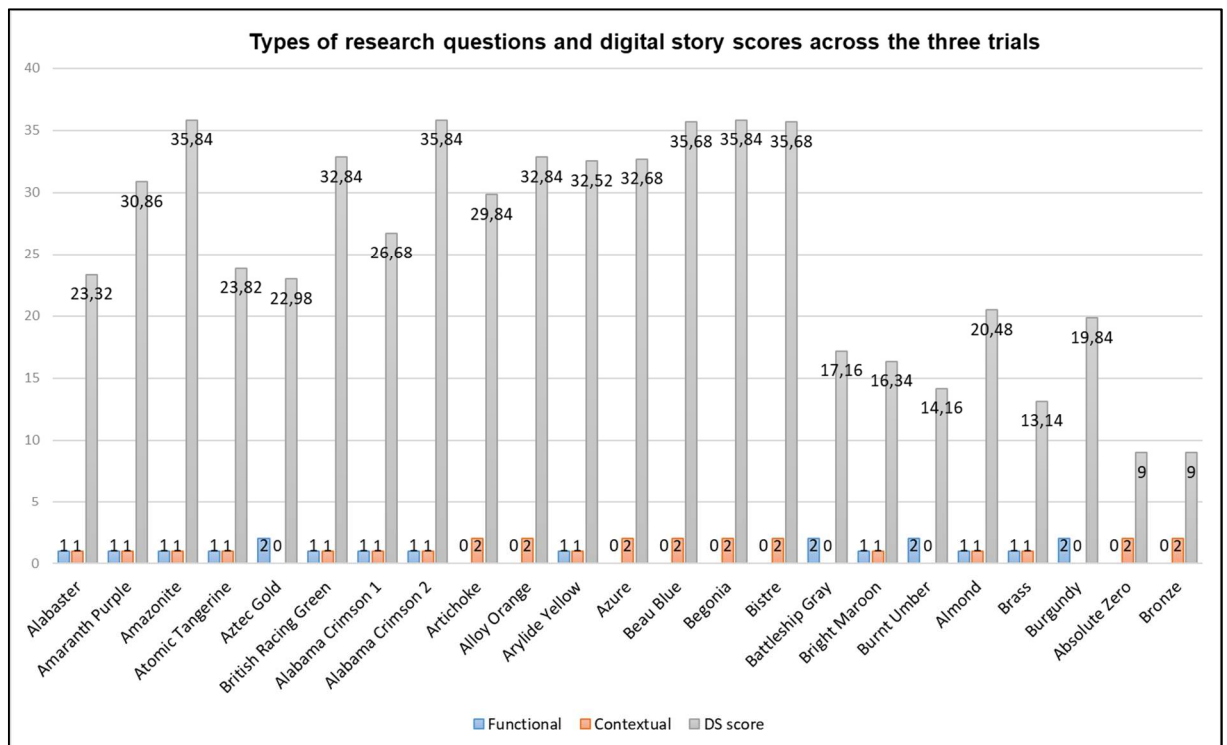
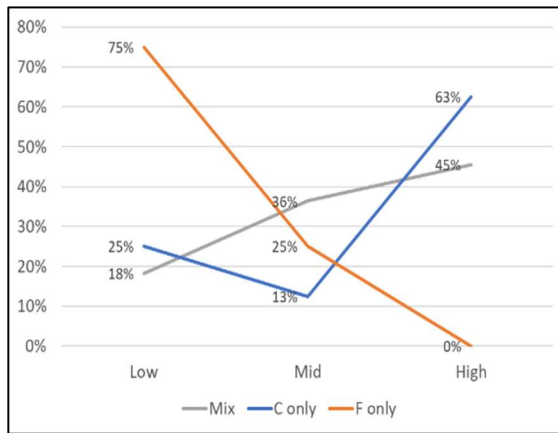
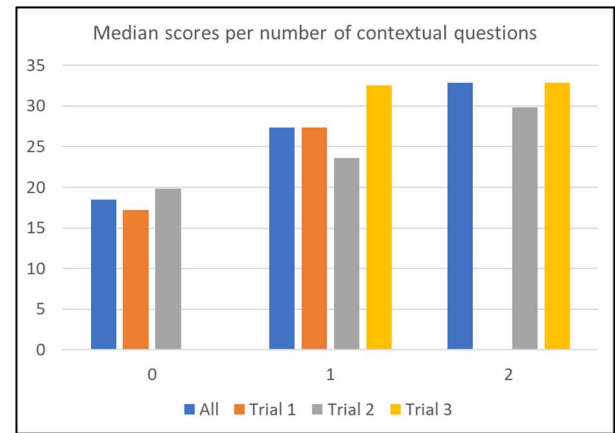


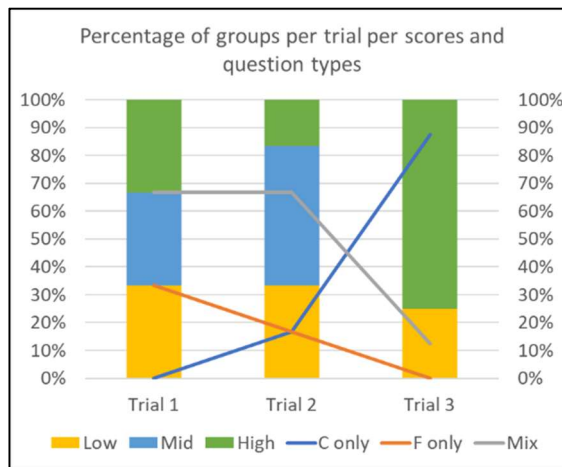
Figure 7.1: The types of research questions and each group's digital story score across the three trials.



(a)



(b)



(c)

Figure 7.2: (a) Percentages of groups with mixed questions, contextual-only questions (C only) and functional-only questions (F only) who achieved low, medium and high scores; (b) Median scores per number of contextual questions (0, 1, 2), per trial and across all trials; (c) Percentage of groups per score category per trial (bars) and percentage of groups per question category per trial (lines).

Graph (a) in Figure 7.2 shows the percentages of groups with mixed, functional only (F only) or contextual only (C only) questions who achieved high (>30), medium (20-30) and low (<20) scores in their digital stories. The lines show that the majority of functional-only groups (75%) achieved low scores, while the majority of contextual-only groups (63%) achieved high scores. Mixed questions groups were also more likely to achieve medium (36%) or high (45%) scores than functional-only groups. Graph (b) makes this apparent correlation between number of contextual questions addressed and score

achieved clearer, as it displays the median scores of groups that addressed 0, 1 and 2 contextual questions, per trial and across trials (missing bars indicate that no groups in that trial addressed that number of contextual questions). Graph (b) shows that the median score increases with the number of contextual questions addressed, both within each trial and across all trials.

The apparently positive correlation between number of contextual questions and digital story scores led me to look further into groups' choices of types of questions. Graph (c) illustrates the percentages of groups that chose different types of questions (lines) per trial, as well as the 'make-up' of each trial in terms of percentages of groups that achieved each score band (bars). The bars in graph (c) indicate that groups in the third trial were more likely to achieve high scores; that groups in the second trial were more likely to achieve medium scores; and that groups in the first trial were equally likely to achieve low, medium or high scores. The lines in the same graph indicate that groups in the first and second trials were more likely to choose mixed questions, while groups in the third trial were more likely to select contextual only questions. Also, groups in the first trial were more likely than groups in any other trial to select functional-only questions. This graph reinforces the positive correlation between contextual questions and high scores. But it also indicates that groups in the second trial were more likely to include at least one contextual question than groups in the first trial, and groups in the third trial were much more likely to include two contextual questions than groups in the first and second trials. These findings align with what Gartenhaus (1999) said about open-ended questions for guiding museum explorations because these 'prompt the many, varied, unique, and detailed ways of thinking one needs to produce in order to fully understand' (1999: 2).

It is important to note here that the subject in each trial might have influenced the types of questions student groups set in lesson 1. It is possible that students in trial 3 felt more inclined to form open-ended, contextual questions than students in trials 1 and 2 because of the nature of the English Literature subject, which impacted how they chose their topics. Age and maturity level (as experience with inquiry-based learning is expected to accumulate

spanning Grades 6 to 10) are also assumed to have had an impact on the groups' low and high overall performance across the trials. It is possible that students in trial 3 conceptualised their inquiries and stories in an advanced way, which helped them produce a better digital story, because they were older than students in trial 1 and 2.

Due to the limited sample sizes and lack of data on other potentially contributing factors, I take these findings to indicate rather than prove a causal relationship between number of contextual questions and digital story scores. To better understand whether a causal relationship in fact exists and why, we would also need to look at the factors that led students to select certain combinations of question types in each trial. Factors to examine include the type of museum and/or interpretive approach: Was there something intrinsic to the V&A's digital collection that invited more contextual questions than the FEMMTH and NOESIS exhibitions? Were the interpretive texts in the different museums putting more or less emphasis on the objects' context versus function, which in turn inspired more or fewer contextual questions? Were there subtle differences in how students were guided to use the hand-outs and formulate questions that led to different combinations of functional and contextual questions? Are the students' age and exposure to similar topics previously in the course contributing factors to the types of questions they choose? Or is digital storytelling naturally better aligned with contextual rather than functional questions when it is used to frame a museum inquiry?

For this last question I can, in fact, find some evidence in my data. The connection between type of question and quality of story seems to pass through data collection, i.e. the type of question impacts the amount of relevant information that students find, which in turn impacts the quality of the story in terms of plot development and question answering. It seemed that contextual questions allowed students more freedom in their data collection. However, these questions led to less information collected because they were mostly open-ended. Bistre for example explained that 'because of the specific choice of topic' they were not able to find relevant photographs that would help them 'illustrate the story as well as' they wanted. As a result, students had to use

more of their imagination and creativity to develop plots that matched the information collected. These groups, which had set at least one contextual question and either adjusted their scripts or used external sources, scored higher than the groups which had functional-only questions. Herein there is a risk associated with the liberties of creative writing and the elaborate use of the museum content, which has accurate and valid information, for a digital story. But the digital stories were assessed on whether they answered the questions rather than how well they did so. If students were to produce videos for an exam, perhaps functional questions would have been more appropriate. For digital storytelling though students were expected to employ their imagination and manipulate the museum content to blend facts and fiction. Therefore, to form questions that better fit digital storytelling in a museum inquiry students should be given more information in lesson 1 about the museum content, including more photographs of the exhibits, to get a better idea of the collection before they choose their topic and form questions that ideally include at least one contextual question, allowing them some flexibility in their data collection.

Another interesting insight coming out of the analysis regards the process of conceptualising the story and how important access to the museum content is when developing characters and events, and while drafting the script. Data across the three trials showed that all groups used the storyboard in the first stage to plan their digital stories and choose a point-of-view to develop their script. The intended role of the storyboard was to support students in planning the purpose and layout of their digital story by envisaging how visual material and script would work side by side and how audio-visual effects would complement these primary materials to convey events, meanings and emotions. The majority of the mid-achieving and high-achieving groups reported that the storyboard helped them get a focus and organise their data ('it helped us plan how we were going to do the actual story' (Artichoke)). However, there were groups, both high-achieving and low-achieving, that did not find it useful (Battleship Gray, Burnt Umber, Almond, Arylide Yellow and Begonia) either because it required too much writing or because they had come up with their own basic storyline already. Only three groups in the first

trial (Alabaster, Amazonite and Atomic Tangerine) included information about the audio-visual effects required. This suggests that planning for the use of transition effects and/or background music to enrich their digital story was not a priority in this first stage (however, this may relate more to students' film literacy and their understanding of the importance of audio-visual effects in communicating meaning).

Storyboarding is an integral part of the digital storytelling process (Ohler, 2007). The storyboard gives shape to the story, leading to the identification of the (sequence of) audio-visual elements that will best convey it. When digital storytelling is used to frame a museum inquiry however, the identification and sequencing of audio-visual story elements is more complicated. This is clear from the different approaches that groups took to this task across the trials. More specifically, the mid-achieving and high-achieving groups across the trials developed a storyline (at least basic) with characters and a series of story events, which guided their data collection. In the third trial in particular, some groups developed a less structured plan, i.e. a 'very basic storyline and idea' (Arylide Yellow because at that point they did not know 'what the script will be about'), while others detailed the characters' actions and words (Begonia). Both sets of groups were able to fully develop the scripts only after commencing the museum investigation. The final version of the script was written after their museum inquiry was completed, using the knowledge they gained to progress their story crafting; and using their developing story to further interrogate the collection.

Whereas the low-achieving groups across the trials either did not draft a script, a character or an event; or had a character and/or an event but no ideas for further development, which was different from the mid-achieving and high-achieving groups in terms of details in the storyboard and which impacted how the plot was built (lacking a connecting thread that would present the answers to the questions with a beginning, a middle and an end). Like the mid-achieving and high-achieving groups though, I noted that 'students complained that they could not draft the script without getting more information about the exhibition'. They did not have the necessary information at that stage. Especially in the

second trial where the digital storytelling process came after the museum investigation, the interplay was not as straightforward as when the planning stage includes activities related to both processes. They were not able to create fictional elements and draft scripts with the collected information. This could be the outcome of not having the story in mind while exploring the museum content, or because they needed more information after having developed a story idea. But it seemed that they were not successful in generating story materials not because they had not found enough relevant information but because the inquiry process took over the digital storytelling process, not allowing the development of the story to generate its own sub-questions with which to re-interrogate the museum content.

The post-intervention teacher interview in the third trial also pointed towards the need to allow students to familiarise themselves with the museum content in advance of storyboarding. By doing so, the interplay between the inquiry and the story is heightened as students are free to adjust their searches (elaborative keywords for the online search or different approaches in taking photographs and notes onsite) and their story plans to the findings. This meant that exploring the museum content should commence earlier, either in lesson 1 to scaffold their question setting or in lesson 2 before drafting the script to allow the writing to be guided by the search results.

I have discussed above how the inclusion of contextual questions to focus the inquiry allows more flexibility in the identification of story materials and thus it yields better digital stories; and how the planning of the story and script generates additional sub-questions that can trigger further, more focused museum interrogations. These findings thus expose an indisputably dialogic relationship between the museum inquiry and the digital storytelling processes in this first stage of the *DiStoMusInq* framework.

## **Stage 2: Data collection/generation, analysis and synthesis**

In the second stage, students engage in collecting and creating information while exploring the museum content to produce digital stories, which present



the answers to their group inquiries. To do so, they exercise research, visual arts, language arts and digital literacy skills such as browsing, reading, aesthetic valuing, taking photographs and notes, recording and editing. The data across the three trials showed that all groups completed the data collection but success in the synthesis varied. The observation data showed that groups across the trials had nearly uniform experiences in the museums, including the V&A's digital collection (see figure 7.3).

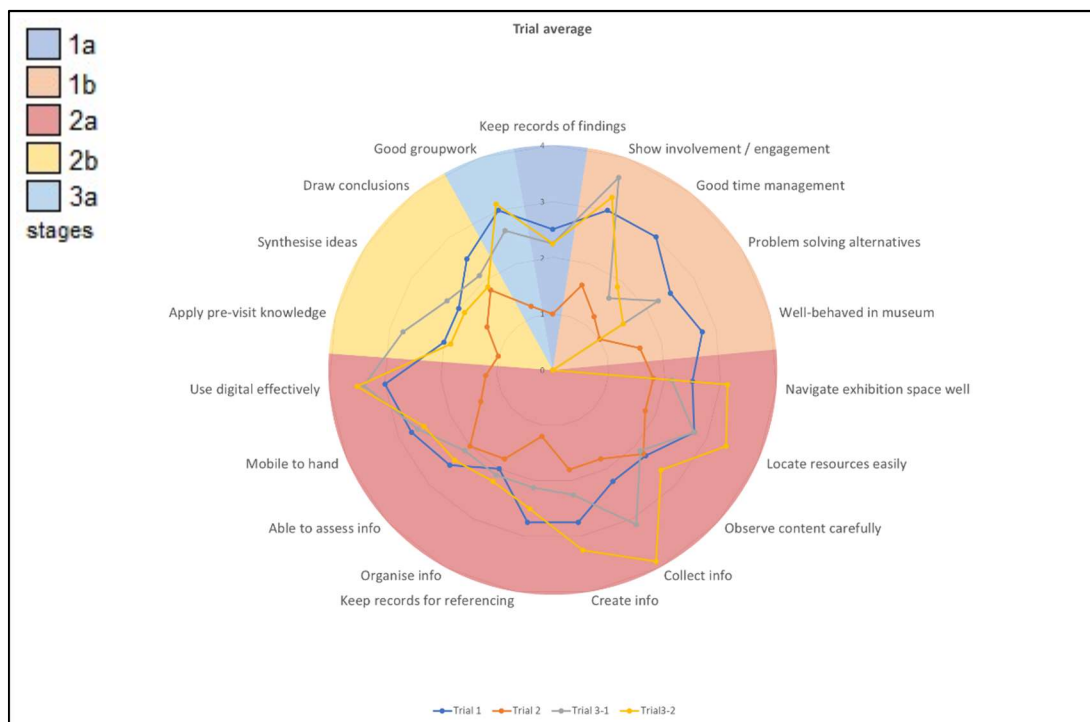


Figure 7.3: Averages of the most frequently observed activities during student groups' museum investigations in all three trials.

In the second trial there were fewer observations compared to the first and third trials, possibly because the chaperones were stricter with marking a tally. Nonetheless, patterns appear. Students were highly engaged in material exploration and managed to navigate the exhibition space well (in the third trial this value was invalid). I also noticed 'students' excitement to collect information'. They used their own mobile devices (smartphones, tablets and laptops) effectively to locate resources and observe the museum content carefully. Groups in the third trial outperformed groups in the first and second trials in terms of collecting and creating information possibly because they had

set contextual research questions, which allowed them more flexibility and/or because they had access to the museum content via the digital collection whereas students in the first and second trials did not.

Also, significant activity was observed across the trials in terms of students assessing the relevance of information, organising it and using it to draw conclusions and synthesise it. This led to all groups subsequently reporting significantly increased confidence in research skills related to data collection and analysis; and even though the low-achieving groups failed to successfully integrate historical information within their fictional stories, all groups included some historical information in their digital story. This agreed with Kuhn et al. (2000), who found that in inquiry-based learning students develop the competency to acquire knowledge in ways that they initiated and controlled, focusing on what they want to learn instead of how. Furthermore, groups in the first trial performed better in time management and problem-solving compared to the rest of the groups observed, possibly because they had planned both the inquiry and the story in lessons 1 and 2 and thus their data collection was more focused.

The photographic data also showed that groups across the trials had nearly uniform experiences during the museum investigations, collecting their data onsite in trials 1 and 2, and online in trial 3 (see table 7.1).

Group		Museum inquiry lesson	Activities									
			CL	RA	RT	RV	TE	TP	UK	UH	US	WT
Trial I	Alabaster	3	+		+	+		+	N/A		+	+
	Amaranth Purple	3	+	+	+	+	+	+	N/A	+	+	+
	Amazonite	3	+	+	+	+	+	+	N/A		+	+
	Atomic Tangerine	3	+	+	+	+	+	+	N/A		+	+
	Aztec Gold	3	+	+	+	+	+	+	N/A	+	+	+
	Battleship Gray	3	+	+	+	+	+	+	N/A			
	Bright Maroon	3	+		+	+		+	N/A		+	+
	British Racing Green	3	+	+	+	+	+	+	N/A		+	+
	Burnt Umber	3	+		+	+	+	+	N/A			+
Trial II	Alabama Crimson 1	2	+	+	+	+		+	N/A	+		+
	Alabama Crimson 2	2	+	+	+	+		+	N/A	+		+
	Almond	2	+	+	+			+	N/A	+		+
	Artichoke	2	+		+	+		+	N/A	+		+
	Brass	2	+		+	+		+	N/A	+		+
	Burgundy	2	+	+	+	+		+	N/A	+		+
Trial III	Absolute zero	3	+	N/A	+	N/A	N/A	+	+	N/A		
		4	+	N/A	+	N/A	N/A	+	+	N/A	+	
	Alloy Orange	3	+	N/A	+	N/A	N/A	+	+	N/A	+	
		4	+	N/A	+	N/A	N/A	+	+	N/A	+	+
	Arylide Yellow	3	+	N/A	+	N/A	N/A	+	+	N/A		
		4	+	N/A	+	N/A	N/A	+	+	N/A	+	
	Azure	3	+	N/A	+	N/A	N/A	+	+	N/A	+	+
		4	+	N/A	+	N/A	N/A	+	+	N/A	+	+
	Beau Blue	3	+	N/A	+	N/A	N/A	+	+	N/A	+	+
		4	+	N/A	+	N/A	N/A	+	+	N/A	+	+
	Begonia	3	+	N/A	+	N/A	N/A	+	+	N/A	+	+
		4	+	N/A	+	N/A	N/A	+	+	N/A		+
	Bistre	3	+	N/A	+	N/A	N/A	+	+	N/A	+	
		4	+	N/A	+	N/A	N/A	+	+	N/A	+	+
	Bronze	3	+	N/A	+	N/A	N/A	+	+	N/A	+	
		4	+	N/A	+	N/A	N/A	+	+	N/A	+	+
CL: close looking, RA: recording audio, RT: reading text, RV: recording video, TE: touching the exhibit, TP: taking photographs, UK: using keywords, UH: using the hand-out, US: using the storyboard, WT: writing text.												

Table 7.1: Photographic data tags during student groups' museum investigations in all three trials.

In fact, students were seen in at least one photograph close looking at the exhibits or observing carefully the photographs that came up in their web-

based searches, reading the interpretative text on the panels, taking or downloading photographs, taking notes, recording audio and video of themselves reading labels and panels, or of the sounds and motion of museum exhibits in operation. As suggested in the literature (Fries-Gaither, 2010) students had to find resources, determine their relevance and accuracy of the collected information, and make use of it in ways that would best serve the purpose and intent of their story. What I found interesting was that, consistently with the first trial where students reported that interacting with the exhibits was the least useful activity, in the second trial students were not seen handling the exhibits despite having the opportunity to do so. This puts into question Caulton's (1995) advocacy for hands-on exploration, particularly in science museums, as essential in facilitating understanding and guiding discovery learning. In this study, it seemed that hands-on material exploration was not necessary for the collection and/or creation of information, because students did not have to touch the exhibits to find the answers to their questions. In fact, the questionnaire data suggested that the most useful activity was taking photographs (followed by close looking and note-taking). The majority of the groups used video for illustrative purposes (even though some low-achieving groups, e.g. Aztec Gold and Brass, depended heavily on it, which compromised the content and quality of their audio narration). As digital storytelling is dependent on audio-visual content rather than reporting tactile experiences, hands-on material exploration seemed relevant to question answering but irrelevant to the story production itself.

Another interesting insight related to how the amount of relevant information found in the exhibition or in the digital collection impacted the story plots and how the digital stories scored in terms of second stage-related work. The data showed that groups across the trials faced issues with plot development and question answering while producing the digital story. Even though all groups conducted their museum investigations successfully (i.e. answered their questions), low-achieving groups did not manage to work the historical information into their stories effectively. They did not employ their imagination to create story elements that would facilitate this such as an imaginary event (e.g. Beau Blue) or their interpretation of historical information (e.g. British

Racing Green) that would contextualise or complement the information. Such scripts read more like answers to exam questions, because students failed to develop plots that presented the answers to the questions through the words or actions of characters in a series of events. They depended heavily on photographs and/or video neglecting the script (which invariably reproduced museum text), and simply presented historical information without embedding it into a story with characters, personal thoughts, imaginary events or interpretations of historical events. According to Maniotes et al. (2016) it is important for students during the analysis to 'choose what is personally meaningful and compelling about their inquiry question' and 'to integrate the ideas more firmly into a deep understanding' (2016: 12). In both the first and second trials, it seemed that the inquiry took over the story because they put together the story materials as if for an exam-like video presentation. The low-achieving groups produced scripts that just relayed factual information and their digital stories either had no plots or had plots lacking a story structure. I noted that 'students found it difficult to build fictional characters with what they had collected' even though 'they reported they had enough information needed to answer their questions' and that 'they would like to go back to the museum to collect missing information now that they had parts of the digital story almost ready'. This meant that (especially in trial 2 where students collected information without having a story in mind), not having access to the museum content for the story production hindered their efforts to synthesise the information to tell a story with the answers. This links to how beneficial for learning students found the framing of their museum inquiries around a digital story when they had a story in mind (trials 1 and 3) and when not (trial 2).

However, mid-achieving and high-achieving groups took a different approach to solving this problem in the synthesis stage. Lacking historical information made them use more of their imagination and creativity to craft fictional elements (such as characters or events), which filled-in any gaps in the facts. For example, Artichoke created a fictional character to fit the intent of their story, and Azure sketched imaginary scenes inspired by true events to complement the life narrative of their fictional character. The high-achieving groups presented the answers to their questions through a well-structured plot,

which had a beginning, a series of events and an ending, and they enriched their story with fictionalised historical information. They finalised the script after elaborating on the notes they had taken on the storyboard, including the thoughts of the characters weaved in the actions and events. This adhered to Czarnecki's (2009b) claim about inductive reasoning in story building, positing that during the analysis and synthesis of story materials students make critical decisions about what to include or exclude from the story based on the purpose and intent each element might serve.

Especially in the third trial, half of the groups described the data collection and the conceptualisation of the story as each feeding into the other (e.g. 'as the story went on we collected and took photographs from the museum database' (Absolute Zero)); while the rest of the groups gave priority to the digital story over the inquiry. In both cases, there were groups that did not find visual material that matched the needs of their scripts, and they instead opted for using other (non-museum) material (which Almond and Brass in the second trial also suggested), or for adjusting their scripts accordingly, or for drawing illustrations themselves to communicate the intended messages. Either approach required flexibility in developing the plot in response to the results of their search for museum content. This meant that searching for suitable information and visual content, onsite or online (as well as in external sources if needed) should be part of the story planning, just as re-drafting the script guided by the search results should be part of the data collection.

The students' work in the second stage confirms *DiStoMusInq* as a multi-step question setting and answering process. While in the first stage students set the overarching questions, the second stage forces them to set sub-questions in the form of queries of museum content suitable for illustrating their developing stories. Also, while in the first stage students define their story idea and outline the characters and events, the second stage forces them to revise their stories in response to querying the museum content. This back and forth between specifying the parameters of one process while processing the findings of the other (i.e. specifying the storytelling while processing the inquiry

findings or specifying the inquiry while developing the story) seems to be a pattern across the first two stages.

Learning outcomes in the synthesis stage therefore depend on two factors. One is the type of questions students had set. The groups that set at least one contextual research question seemed to be more flexible to adjust their story plans and manipulate the collected information; possibly, because of the open-ended nature of their inquiry that allowed them freedom in their searches and creative writing (as discussed above). Another is the level of scaffolding and support that students receive with creative writing, which both the students in the third trial and the teacher in the post-intervention interview also suggested. Students would have benefited from being trained in writing historical fiction. Exercises for text analysis and language drills using excerpts from such literary works would help students get a better idea of how a story may include historically accurate and scientific information without necessarily compromising the validity of the information by elaborating on story elements such as emotions, thoughts and words, but rather enriching it. Also, it is recommended to revise the storyboard and include a specific section for the collected information (associated with the inquiry) and a specific section for the created information (associated with the story). By doing so, students would have better control over the data collection and with scaffolding in creative writing blending of facts with fiction in the synthesis stage would work better.

The second stage also highlighted important technical issues that students faced in the digital storytelling process. Across trials student groups in all achievement bands had issues with the editing and producing audio narrations using their smartphones. Many groups had to redo it several times ('in order for it to be perfect', Bistre) either because of background noise or because they wanted to capture a certain tone in their voices. This suggested that because audio-recording the script brings the story to life (Banaszewski, 2002; Lambert, 2010) it requires focus to be done properly. Once finalising their scripts students should be given time in a quiet classroom to audio-record their scripts one group at a time, to minimise interference from background noise. Basic training in voice-over could also be a useful addition.

Another technical issue that students faced was how to arrange the sequence of the photographs to match the audio narration or how to make the video frames of the available photographs last long enough to cover the whole of the audio recording. Perhaps students should be given more time to explore the software and/or be shown digital stories beforehand to get an idea of how a finished digital story could look like ('maybe show [us] something that is already done' (Azure)). Possibly they would have benefited from having access to the museum content, not only while conceptualising the story but also during the story production, because they would have been able to collect more visual content as needed (e.g. Bistre and Bronze went back to the digital collection to look for more photographs). That is because both low-achieving and high-achieving groups in trials 2 and 3 asked for more time (which I noted in the first trial as well 'they got frustrated over the limited time to edit'). Editing is time-consuming and they should have time to engage with it fully, potentially separately from the *DiStoMusInq* intervention, for example in the context of parallel ICT homework. Subsequent engagements with this activity, once the 'newness' of the software tools has faded, will be more time efficient.

It was also notable that students experimented with the transition effects and groups from all the trials (Alabaster, Amazonite, Atomic Tangerine, Alabama Crimson 2, Almond and Beau Blue) used background music to enrich their stories. Groups across achievement bands in the first and second trials (Amaranth Purple, Alabama Crimson 1, Alabama Crimson 2, Almond, Artichoke and Burgundy) added parts of the script as a transition effect onto some photographs. This indicated that they explicitly wanted factual information to be blended in with the story materials, suggesting that the digital storytelling and the inquiry processes were at interplay -perhaps even at tension. However, there were students in trials 1 and 3 (Burnt Umber, Beau Blue and Bistre) that asked to use a different software for editing. Similarly, the post-intervention teacher interview also highlighted the need to have reliable technical support and offer both teachers and students hands-on application training before commencing the editing ('editing was a little hard for them because it was new'). This meant that better instruction should be provided (e.g. how to upload photographs, import the audio narration, use transition



effects or rendering tools) to demonstrate features and troubleshooting. Again, this highlights how the ICT syllabus can blend into a *DiStoMusInq* intervention.

Last but not least, citing sources appeared to be a recurring issue across the trials even though students were expected to be familiar with and competent in this task. According to Calder (2015) having control over the inquiry process adds to student ownership, which is strengthened by the credibility of the outcomes. Similarly, the credibility of a digital story depends on how the investigation was conducted (Porter, 2005). But the digital stories of the majority of groups, irrespective of level of overall score, scored very poorly in citing. Students had been taught how to use references and despite the different type of output, there is nothing to suggest they did not know how to do it because I had informed them in lesson 1 (with a reminder in the Power Point presentation) to keep records of their sources for referencing. Besides that, the observation data showed that the majority of the groups were seen record-keeping in the museum and when visiting the digital collection. It is possible that students in all trials knew how to cite their sources, but they forgot to do it in the form of a video. Or perhaps their note-taking was not effective enough or better instruction should have been provided along their data collection. Nevertheless, I found it interesting that in the second trial only the low-achieving groups had an issue with citing. Perhaps in the ICT Literacy subject this part of the inquiry process (referencing) was better covered in class in reference to copyright and intellectual property rights compared to the Art History and English Literature subjects. Future research should look into how better instruction (clarify why it is important to show respect for the work of others and be able to help distinguish their work and to follow-up) would impact the way students apply prior knowledge of elements of the inquiry process like citing sources in the story production.

### **Stage 3: Sharing, peer review and reflection**

In the third stage, students watch their digital stories and engage in group discussion to reflect on the learning process. To do so, they exercise language arts and social skills such as listening, speaking, peer-reviewing, negotiating

and decision-making. The analysis showed that students worked together throughout the intervention and in their majority commented positively on the quality of their group work. Even though in the second trial there were fewer observations compared to the first and third trials of students collaborating during the museum investigation, I noted that 'the fact that each group had chosen a specific topic facilitated achievement as groups did not intervene in each other's work and students could spend a longer time exploring the museum objects without having to move on to the next'. Alabama Crimson's group decision to split into two sub-groups was successful ('we are happy with what we did as a pair' (Alabama Crimson 1)). The photographic data revealed that particularly during the data collection students talked to each other and collaborated to locate information and collect and/or create story materials.

Furthermore, the questionnaire data across the trials revealed an increase in their confidence to work as a group and receive feedback. The British Racing Green representative stated that 'we worked more easier [sic] as a group when we helped each other'. Especially in the third trial I noticed 'high collaboration levels were noted as students worked together well and completed an equitable share of work'. In hindsight, students reported that they worked well together, better than they had expected, and that they learned how to negotiate (Begonia), think outside the box (Beau Blue), work as a team (Azure) and be more open-minded (Alloy Orange). In agreement with the literature (Behmer, 2005; Harrison, 2014; Stanley and Dillingham, 2011), the reflective interview findings showed that students employed communication and collaboration skills. For example, Bistre said that 'I loved working with my partner to write it down. And to share our ideas, to create something that we believe worked great for our story'.

In the class discussion that followed in the last lesson of the third trial students reflected on both the process and the outcomes. I noticed that 'they seemed happy to explain the rationale of their decision-making while crafting the digital story' and they shared how they solved the problems they faced. The teacher in the post-intervention interview said that she would 'probably let each student do his or her own project rather than doing it as group work'. But it seemed to

me that even though in both Art History and English Literature students were used to working individually on inquiries, placing more emphasis on collaboration has had no negative impact on their performance and they were able to cooperate effectively.

Three questions arise after the trials, which are worthy of further exploration. First, should students be given the option to choose their partners themselves rather than the teacher placing them in a group (as was the case in the three trials)? Although the groups worked well together, research (Griffin, 2004; Katifori et al., 2016) suggests that self-selected groups have benefits. Even though in this study students were allowed to conduct the museum investigation in a way that they controlled (adjusting levels of social engagement as they wanted to among group members), future research could look into internal and external motivation levels and how group work performance is impacted by the choice of partners. Second, how do students share the workload, manage expectations and negotiate roles to mobilise expertise or divide responsibility? Previous studies (Hafner and Miller, 2011; Lambert, 2010) have showed that social skills play an important role in both the inquiry and the digital storytelling processes as students interact, communicate and collaborate. It is thus worthy of further exploration to examine the quality and intricacies of group work in the course of a *DiStoMusInq* intervention. And finally, what is the role of the museum guide as a facilitator in self-initiated and self-directed museum exploration? The findings question the extent to which students found the museum guide helpful for their inquiry work. In the second trial particularly, asking the museum guide questions to collect additional information was listed as the least useful activity. This indicated that in self-directed explorations where students remain in control of the learning process, the amount of scaffolding required by students is low. This should be further examined and juxtaposed to group work and the students' control level over the learning process.

### **7.2.2 Why do a *DiStoMusInq* intervention?**

In this section I present and explain the applied value of having a digital story frame students' museum inquiry for research skills development and as a way of investigating and approaching museum objects [through story-driven personal interpretative pathways with student control over the objectives (their research questions) and the outcomes (their digital stories)].

Firstly, as discussed in section 2.3.3, the museum can be a place of research (Johnson and Quinn, 2004), where students make sense of concepts through investigations (Allen and Gutwill, 2009). The study confirmed that self-initiated and self-directed museum investigations are possible and the impact of such purposeful engagement on their research skills development was positive. Across the trials there was improvement in students' perceptions for all research skills competence levels with the most improvement observed in the first and second stages. This insight confirmed the literature review findings that students' questioning skills develop (Buckner and Kim, 2014: 114) through self-initiated and self-directed inquiries. More importantly, they experienced advancement of research skills even when the score of their digital story was poor. This suggests that digital storytelling framed their data collection in a way they considered successful, which is an interesting insight because it confirms that when having a focus, particularly a story focus, students are highly engaged in material exploration. They took control (Harlen, 2014), applied prior knowledge of the inquiry process in the museum context and successfully conducted group inquiries onsite and online. By doing so, they managed to connect with the subject matter on a more personal level, trying to reach an understanding that goes beyond conceptual norms (Springer et al., 2004). In agreement with Banz (2008) it seemed that students chose what to observe and how to interpret the information; and they paid attention to what they observed to make sense of their topic (Yeomans, 2011).

Another benefit was that students took different points of departure in their museum investigations, which allowed for different trajectories of inquiry that corresponded to different ways of internalising the newly acquired knowledge. In doing so, the objects 'serve as springboards, or points of

departures, for their own additional ideas, alternatives, and insights' (Gartenhaus, 1997: 48). Since each group had chosen their own topic, members were free to customise their data collection, acknowledging that some might have different kinds of prior knowledge than others; and they were responsible for self-directing and managing how they navigated the exhibition and engaged in investigative tasks using their mobile devices (how, of what and when to take photographs, notes, record audio and/or video). This aligned with MacKenzie's (2016) claim that in inquiry-based learning, student ownership is heightened, leaving room for the voice of the student to be heard.

Secondly, in terms of story-driven personal interpretations of the museum content, the study showed that digital stories allow students to become explorers, interpreters and contributors to the museum narrative (Johnsson, 2006; Roberts, 1997). The findings aligned with constructivism-based museum learning, which posits that meaning-making is both a process and a product (Hein, 1998a; Hein, 1998b; Jeffery-Clay, 1998; Wyman et al., 2011). By taking control over the outcome as well, students were allowed to be creative (e.g. in choosing the visual content, in script and plot development, and in editing) and to externalise, unassisted, the newly discovered knowledge in the form of a video (e.g. in the third trial the majority of the groups took pride in their digital story). In this sense, the study offers an answer to Runnel and Pruulmann-Vengerfeldt's (2012) question of what kind of participation museums call for by diversifying the audience engagement and learning agendas. Each group's digital story was assessed by whether it provided answers to the questions set or not but there were no right answers to which a digital story's answers were compared. This re-contextualised what Ross et al. (2014) perhaps meant by saying that the stories museum visitors craft 'are directed not toward the acquisition or receipt of the information being communicated by the museum but rather toward the construction of a very personal interpretation of museum objects' (2014: 277-278). Each group's interpretation of the museum content was equally valued as a creative response, leaving all students with a sense of worth and ownership. I understood that digital storytelling is a way to explore 'the creative impulses' of the museum visitors (Hein, 2006: 5) because it gives voice to their diverse and subjective experiences (Hooper-Greenhill, 1999: 70).

It allows them to use information from authentic resources ('we saw the importance of [...] using a museum database' (Azure)) and blend facts with fiction in their own way of sense-making, while employing the higher cognitive functions that enable us to manipulate knowledge and make it our own.

Fuhler (2010) and Staiff (2014) seem to agree that storytelling sutures cultural heritage into a particular form of representation that has action, agency and causation. In that light, museum investigations framed by digital stories pave the way for multi-modal narratives (c.f. Page, 2010) and learning by crafting historical fiction, using reliable information from authentic sources such as a museum collection. Especially in trial 3, it seemed that digital storytelling worked well because it was associated with literature. There are different ways students dramatized, and could have dramatized, the museum content: by inventing characters and placing them in fictional or historical events, or by visualising what real people would have said or done in an imaginary or real situation in the past. It is worthy to compare the drafts to the final scripts (further scrutinizing language use and fictional elements) to understand the interplay between presenting and interpreting historical information through creative writing. This links to the different types of digital stories, e.g. historical, personal or argumentative with an explicit message, students may choose to craft - based on their questions-, and how each type might fit a different museum setting, e.g. a history, a war or a science museum respectively.

### **7.3 Practical contributions**

#### **7.3.1 The refined *DiStoMusInq* framework**

Practically, the research shows how to implement the *DiStoMusInq* framework in school curricula, strengthening the relationship between the private school and the museum in Greece. This knowledge feeds back to the literature a way of applying the framework using a set of principles for the design of an effective instructional *DiStoMusInq* intervention.

The study showed that the interplay between the two processes is neither linear nor sequential. It seems to be cyclical and dialectic, with each stage feeding into the others, exposing the symbiotic relationship between

inquiry and digital storytelling. Building on Pedaste et al.'s (2015) claim that 'inquiry-based learning can be seen as cyclical on multiple levels' (2015: 57), the framing of the inquiry with a digital storytelling task encourages multiple cycles of inquiry, with each cycle focusing down closer on specific elements of the digital story. This finding led me to refine the *DiStoMusInq* framework in such a way as to re-arrange the three stages to include the nuanced overlaps between its sub-stages as shown in Figure 7.4.

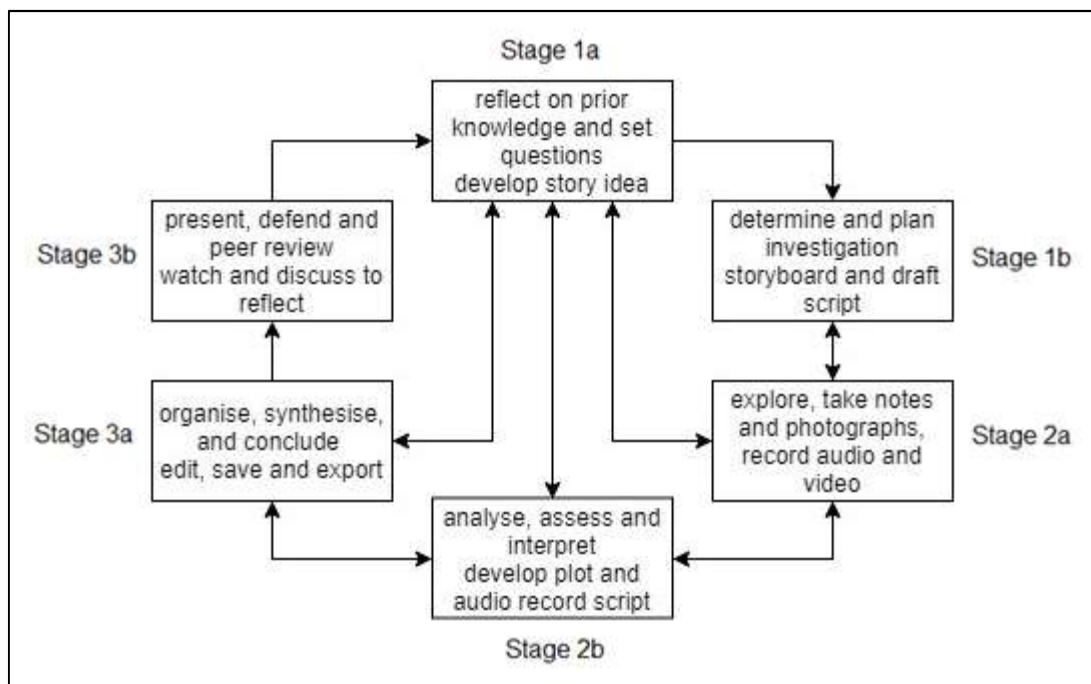


Figure 7.4: The refined *DiStoMusInq* framework.

The framework still consists of six stages but there is a continuous give-and-take, particularly with three of the sub-stages, which are reciprocally linked to the first one. The refined stages and sub-stages are: 1a) conceptualize and develop a story idea, 1b) plan the museum investigation; 2a) data collection and generation (revisit story plan) and 2b) analyse the information and develop the plot (revisit story plan and/or collect more information); 3a) synthesise the story materials and 3b) present, peer review and reflect.

The findings lead to the following principles per stage. Teachers should set aside class time for at least eight lessons and either organise a physical visit to a museum and/or a web-based visit capitalising on museum digital collection

and archives that are accessible online. And students should have reliable technical equipment and have downloaded the relevant applications on their mobile devices and received technical training in advance. They form groups of two or three either on own initiative, i.e. choosing their partners, or assigned in groups by the teacher.

In lesson 1 they are given general information -including photographs of the objects exhibited- to get an idea of the museum's collection and they start by reflecting on their prior knowledge to decide on their topic. The teacher might draw on relevant topics previously covered in the curriculum to help students make these personal choices and connections. In this lesson, students use a hand-out to set personally-relevant research questions. The handout and/or the teacher guide students to practice question setting (for example by suggesting example questions) and to appreciate the importance of including contextual questions in their inquiries. As Pedaste et al. (2015) explains, if students start from open-ended questions, it is expected that they will return to the conceptualisation stage once they have revised or derived new ideas from the data gathered. Contextual questions, which tend to be more open-ended than functional questions, are therefore more likely to encourage the inquiry-digital storytelling synergies discussed above.

In lesson 2 students develop a story idea, decide the purpose and the point of view and they draft the script, developing the characters and/or a series of events. Reflecting on the needs of their script, they determine what they need to find out and plan their museum investigation using the storyboard. At this stage, the storyboard need not prompt students to think about audio-visual effects, but it should include a section that prompts them to think about sources for citing, separate sections for collected vs. created information, and plans for 'credits' screens. Before concluding their museum investigation plans, students should be encouraged to browse the content available on the museum website or digital collection. This activity serves a dual purpose: on one hand, students have the opportunity to familiarise themselves with the objects before the visit, and on the other hand they have the opportunity to review their story plans according to what content is available. Finally, students



should be encouraged to think about fictional elements of their stories, such as the words of characters, thoughts and feelings, imaginary events or interpretations of historical events; while at the same time they should be asked to question and reflect on how well these fictional elements map onto the historical information presented by the museum.

Lessons 3 and 4 could be planned with reverse focus, as such: lesson 3 is devoted to further exploring the museum content through its website and/or digital collection to develop the plot; and lesson 4 is dedicated to a physical visit if such is possible (after having decided what kind of information the story requires). In both lessons, students are allowed to use their own mobile devices to engage in material exploration: they locate and observe the museum objects, take or download photographs and take notes, record audio and video, and note their sources for later citation. Given that video is trickier to integrate within digital stories, students should be made aware not to depend heavily on it to communicate their intended messages. In fact, a demonstration of different kinds of digital stories at the start of lesson 3 might be beneficial for students in this stage, as it would give them direct experience of what end product they are aiming at and what kind of content they should be aiming to collect. Students should be allowed to draw sketches as their own illustrations if needed, but they should be encouraged to explain how they based the production of such material on evidence they found in the museum or digital collection (for example, if students sketch a scene that depicts the main character dressed in a certain way, they should be able to explain that the character's dress matches the fashion of that period). During data collection students should revisit their story plans and adjust their scripts accordingly, and/or to modify their search criteria to collect more relevant materials as necessary. Throughout these lessons, students should be encouraged to organise, analyse and interpret the material and information they collect to determine its relevance and appropriateness for use in the story production.

In lessons 5, 6 and 7 the students finalise their scripts, elaborating on their notes to fully develop the plot and audio-record the script narration on a smartphone or other recording device in a quiet room. They should be free to

collect more materials if needed. According to the literature, in plot development students should be aware that even though visual content plays an important role for illustrative purposes, the story comes first (Ohler, 2007). But this study showed that the facts (illustrated by the photographs of the museum objects) should play an equally important role too. As discussed above, students should be involved in creative writing exercises learning how to manipulate the historical information and tell a story with an explicit purpose and intent that blends facts with fiction; and how to employ their imagination to develop a plot that presents the answers to the questions through the words or actions of characters in a series of events. To do so, the teacher might share excerpts from literary works of historical fiction that would help students through text analysis and language drills get a better idea of how a story may include historically accurate and scientific information. Students should then be in a position to put the story materials in the software, arrange them in a sequence, use transition effects and/or background music to enrich their story. If relevant training has not been given to students in other ICT lessons, at this stage it is advisable to show students a selection of finished digital stories and demonstrate to novice users how to make the most of the video editing software (e.g. how to upload photographs, import the audio narration, use transition effects or rendering tools). They should also be reminded to cite their sources using credits screens, and how to save and export the video.

In lesson 8 there should be a class screening to watch the digital stories and for students to engage in a class discussion for peer review and reflection. According to Harlen (2014) attention should be paid on how they managed problems and to explain the rationale of their decisions (choosing specific photographs or specific transition effects) and whether they are satisfied with how their digital story turned out. By reflecting on their work and taking responsibility for accomplishments or opportunities missed (Chinn and Malhotra, 2002), they externalise the newly acquired knowledge, exercising meta-cognitive skills (Maniotes et al., 2016), in such a way that 'socially gathered and shared information informs individual learning' (Ash, 2000: 58). Furthermore, to facilitate the feedback exchange on both the outcomes and the process the teacher could ask students to assess each other's work using

the rubric. McNeil and Robin (2012) also talked about having different kinds of assessment (teacher evaluation, peer-evaluation and self-evaluation). Students could use the rubric to assign scores, which then could be compared to the scores the teacher gave and discuss what they would have done differently. Last but not least, the digital stories should be safely stored in a Google Drive © folder for future reference (Lowenthal, 2009) and serve as archival material for students in other grades or different subjects, who want to craft a digital story as the outcome of a museum investigation.

### **7.3.2 How to integrate *DiStoMusInq* in school curricula?**

Curriculum reform in education is dependent on the recognition of changes in the world and advances made in teaching and learning theory and praxis. The *DiStoMusInq* framework is innovative from the vantage point of the Greek reality but not readily applicable to schools, which do not follow an inquiry-based learning curriculum like the International Baccalaureate. Therefore, the suggestions that I make herein apply directly to these kinds of schools only, at least at the time of writing.

The implementation of a *DiStoMusInq* intervention cannot take place in a vacuum. In order to integrate digital storytelling into an existing curriculum and improve the provision for museum visits, certain issues need to be addressed. At an institutional level this study offers useful insights for the school-museum partnership in Greece. Before planning starts though the museum should take a step back from the digital age to rethink their relationship with the visitors, digital savvy or not, and reflect on how this relationship changes and to what direction. The provision for school trips to museums should be continuously assessed by beneficiaries to improve existing synergies in an integrated and inclusive approach. The ways inquiry is represented and becomes accessible (c.f. Achiam and Marandino, 2014) should be open to negotiation, affording students opportunities for personally relevant discoveries. For example, projects such as a Science Fair at school with an exhibition curated by students in a science museum allow interactions on different levels (involving students in design, execution and evaluation) between the museum and its young visitors. To do so, teachers, with the help

of school administrators, should work together with museum educators and curators locally (and internationally) to co-design programs and activities that feed into the museum content or challenge the concepts and intended messages of the objects, targeting permanent or temporary exhibitions.

The school should provide the teacher with the necessary financial and technical support to freely design interdisciplinary units and field trips as student-led museum investigations. The *DiStoMusInq* framework could be the cost-effective (e.g. with a web-based museum visit) interdisciplinary link between different subjects (other than Art History, Information and Communication Technologies Literacy and English Literature), including History, Biology and Visual Arts, and different museum settings, e.g. a war, natural history or an art and design museum.

#### **7.4 Methodological contributions**

Methodologically, the research adds to the field a set of tools available for future *DiStoMusInq* interventions for the further scrutiny of the framework's practicability. More specifically, the instruction (lesson plans and resources) and research designs, including the data collection tools (questionnaires, interview protocols and observation forms) as well as the rubric, can be of use to researchers and teachers who wish to implement the framework and examine its effectiveness in other similar settings and/or with other similar populations. To do so, some improvements are necessary (e.g. fewer prompting questions in the hand-out and a section for keeping records of sources in the storyboard), and adjustments in the rubric to add more criteria (e.g. assessing the use and manipulation of historical information).

In future *DiStoMusInq* interventions, both pre- and post-intervention teacher interviews should be conducted, photographs from each lesson should be taken, observation forms for each group should be filled-in during the museum visit, and reflective student interviews with each group should be done. Also, this study could be done in an experimental way using a probability sample. It should be possible to test the *DiStoMusInq* framework in other settings such as international schools outside of Greece with other age groups, or a larger sample size, in different subjects (e.g. History or Biology) with visits

to different museums (e.g. a history or natural history museum) or web-based museum visits. The affordances of advanced digital technologies with three-dimensional representations and mixed-reality environments point towards new interactions with the objects and among visitors (e.g. MIRACLE (Helle et al., 2017) and Open Virtual Worlds (Kennedy et al., 2013)). These will soon allow students to examine museum objects from different perspectives in virtual and augmented reality environments and craft digital stories with themselves as avatars since story production will also take new shapes. Fieldtrips to museums that capitalise on virtual and augmented realities (c.f. Argyriou et al., 2017; Economou, 2004; Perry et al., 2017; Petridis et al., 2005) offer immersive and intuitive experiences and can pave the way for newly envisioned applications of digital stories in the twenty-first century museum.

In a nutshell, this study made important contributions to scientific knowledge because it furthered our understanding of inquiry-based museum learning and digital storytelling embedded in Greek private school curricula. It showed that digital storytelling can effectively frame self-initiated and self-directed student group museum inquiries onsite and/or online, allowing students control over the learning process and the outcome as they explore and interpret cultural heritage to construct knowledge on their own.

## **7.5 Summary**

Chapter Seven brought together the data across the trials to illuminate how the students performed throughout the interventions and explore how to use the refined *DiStoMusInq* framework, and why its use is of value to teachers and museum educators alike. The contribution of this study is important because it demonstrated how the digital storytelling process could be integrated within an inquiry-based learning curriculum for school trips to museums, and what the benefits of having student-generated digital stories as outputs of self-initiated and self-directed museum investigations are.

## Chapter Eight

### CONCLUSION

#### 8.1 Outcomes overview

As I explained in section 2.4, the literature review brought to the fore the need to explore further how students make sense of museum objects and concepts in self-initiated and self-directed discoveries (customised by questions of personal interest, giving them control of the learning process and the outcomes) to gain insights into how they construct meaning, following their own interpretative and learning pathways.

The *DiStoMusInq* framework proposed the framing of students' interpretations around a digital story, leaving students with a sense of worth and ownership as they plan and produce their group inquiries and digital stories (with the ten elements and a well-structured plot) about the chosen topics of museum interest. Initially, the framework articulated the three-staged mapping between the inquiry-based learning process and the process of crafting a digital story in a linear way, focusing on the corresponding tasks (for which students exercise and develop a similar set of higher-order thinking and research skills). The findings revealed that there are synergies between the two processes, but the interplay is not linear. It is dialectic, with each stage feeding into the others and with inquiry and digital storytelling driving each other. The study confirmed that students benefited from being exposed to this way of investigating and approaching museum objects with control over the objectives (the questions they had set) and the outcomes (their digital stories). The findings have some degree of transferability but limited to similar school or museum settings because this study was exploratory involving students from one private school in Greece only. This meant that what was observed in this study is possible but not guaranteed to be observed in similar settings, thus generalisations to wider populations cannot be made (Bassey, 1999: 52). Nonetheless, the contributions of this study in the field of inquiry-based museum learning and digital storytelling embedded in Greek private school curricula are valuable. The study informed us about the ways in which students can build on prior knowledge of the inquiry process, set personally relevant

questions, investigate the museum content onsite and online, and interpret cultural heritage with the aim to present in a digital story how they made sense of their newly acquired knowledge.

On the one hand, the refined framework is a suggestion for integrating digital storytelling in the existing inquiry-based learning curriculum of the International Baccalaureate to improve the provision for school trips to museums. On the other hand, these insights are useful for unravelling and appreciating the students' visiting experience by enriching the museum's agendas for engagement and learning. We now have another way to look into how students engage in cultural heritage interpretation, how they contribute to the museum narrative their own stories, and therefore how they personalise learning in the constructivist museum. Thus, the *DiStoMusInq* framework is of value to teachers, museum educators and researchers alike.

## **8.2 Future research**

Recommendations for future research are offered looking inwards by further vigorous scrutiny of the existing data. We should look into group work, sharing and social dynamics throughout the stages (e.g. having lower expectations or adopting on purpose a leader's or subordinate role, internal and external motivation levels impacted by the choice of partners, self-and-peer assessment, negotiating roles and shared workload by delegating tasks). The teacher in the post-intervention interview added that assessing group work could help understand how each group managed collaboration. Also, the digital stories should be scrutinised to look into students' choice of photographing objects, sequencing the photographs and editing, comparing the drafts and final versions of the scripts (language use) to understand the interplay between simply presenting historical information and interpreting it through creative writing. Next, further analysis of the existing data is required to expose the role mobile devices played throughout the stages. We should look into user experience and the devices' impact on investigative practices and story production, comparing the observation data to student perceptions of usability as reported in the questionnaires and the reflective interviews.

Last but not least, I would like to discuss how I decided to disseminate the findings presented in the thesis to inform about and contextualise the impact of this study. The publications produced (see List of publications) were subjected to blind peer review for external scientific scrutiny and deposited in the Research Archives of the University of Leicester. Furthermore, on 12 March 2017 I took the initiative to organise a Day Conference with external speakers, entitled 'Digital storytelling in museums and schools', which was hosted in the FEMMTH. The total number of attendees was forty-two (see appendix XIX). My intention was and remains up to the present to write a handbook for teachers and museum educators to share what I learned and promote the use of digital storytelling for inquiry-based museum learning. The handbook will increase the number of beneficiaries, substantiate and extend the contribution of this study beyond its lifetime. I do not wish to impose any doctrine, but I agree with Schein (2013) that 'we must become better at asking and do less telling in a culture that overvalues telling' (2013: 3).



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## APPENDIX I

### Digital story scoring rubric embedded with research skills assessment

Criteria	Excellent 4 points	Good 3 points	Satisfactory 2 points	Needs improvement 1 point
Question setting	The digital story has an inquiry question posed and established early on.	The digital story has an inquiry question posed and established.	The digital story has an inquiry question posed but poorly established.	There is no inquiry question the digital story tries to answer.
Point of view	The digital story has a clear point of view (1 <sup>st</sup> or 3 <sup>rd</sup> person narrative), which is consistent throughout.	The digital story has a point of view (1 <sup>st</sup> or 3 <sup>rd</sup> person narrative), which is somewhat consistent throughout.	The point of view (1 <sup>st</sup> or 3 <sup>rd</sup> person narrative) is not clear or is not consistent throughout.	There is no point of view (1 <sup>st</sup> or 3 <sup>rd</sup> person narrative) chosen.
Information seeking  <i>Originality 0.50</i> <i>Contribution 0.34</i> <i>Variety 0.16</i>	The digital story has a rich variety of visual and audio story materials, either original or gathered from quality sources, selected to serve the story purpose.	The digital story has a variety of visual and audio story materials, mostly original or gathered from quality sources, selected to somewhat serve the story purpose.	The digital story has limited visual and audio story materials gathered from quality sources, selected to somewhat serve the story purpose.	The digital story has limited visual and audio story materials gathered from non-quality sources, or the story materials selected do not serve the story purpose.
Script development and Use of language  <i>Originality 0.50</i> <i>Contribution 0.34</i> <i>Grammar 0.16</i>	The script is original, with correct grammar, and makes a significant contribution to the story purpose.	The script is somewhat original, with mostly correct grammar, and makes some contribution to the story purpose.	The script is not original, with few grammatical errors, but makes some contribution to the story purpose.	There is no script, or the script has many grammatical errors and makes little contribution to the story purpose.
Plot development and question answering	The digital story has a complex plot with events or twists; and/or the question is fully answered.	The digital story has a plot with some events or twists; and/or the question is somehow answered.	The digital story has a plot with a limited number of events; and/or the question is somewhat answered.	The digital story is a linear presentation of a limited number of events; and/or the question is not answered.
Visual content (photos, videos + text)	The digital story has photos, videos or text, either	The digital story has some photos, videos or text, mostly	The digital story has limited photos, videos or text,	The digital story has limited photos, videos or text,

<p><i>P originality</i> 0.50 <i>P contribution</i> 0.34 <i>P quality</i> 0.16</p> <p><i>V originality</i> 0.50 <i>V contribution</i> 0.34 <i>V quality</i> 0.16</p> <p><i>T originality</i> 0.50 <i>T contribution</i> 0.34 <i>T quality</i> 0.16</p>	original or gathered from quality sources, which make a significant contribution to the story purpose and are of good quality.	original or gathered from quality sources, which make some contribution to the story purpose and are of good quality.	gathered from quality sources, which make some contribution to the story purpose but are of poor quality.	gathered from non-quality sources, which make little contribution to the story purpose and are of poor quality.
<p>Audio content (voice recording, music + background sounds)</p> <p><i>V originality</i> 0.50 <i>V contribution</i> 0.34 <i>V quality</i> 0.16</p> <p><i>M originality</i> 0.50 <i>M contribution</i> 0.34 <i>M quality</i> 0.16</p> <p><i>B originality</i> 0.50 <i>B contribution</i> 0.34 <i>B quality</i> 0.16</p>	The digital story has a voice recording, which is relevant and audible. The digital story has music or background sounds, either original or gathered from quality sources, which make a significant contribution to the story purpose and are of good quality.	The digital story has a voice recording, which is somewhat relevant or somewhat audible. The digital story has some music or background sounds, mostly original or gathered from quality sources, which make some contribution to the story purpose and are of good quality.	The digital story has a voice recording, which is not relevant or not audible. The digital story has some music or background sounds, gathered from quality sources, which make some contribution to the story purpose but are of poor quality.	The digital story does not have a voice recording, or music or background sounds, or it has some music or background sounds, gathered from non-quality sources, which make little contribution to the story purpose and are of poor quality.
<p>Synthesis (editing)</p> <p><i>Organisation</i> 0.50 <i>Contribution</i> 0.34 <i>Variety</i> 0.16</p>	The digital story has a rich variety of editing effects; the story materials are well-organised making significant contribution to the story purpose.	The digital story has a variety of editing effects; the story materials are mostly well-organised making some contribution to the story purpose.	The digital story has limited editing effects; the story materials are somewhat organised making some contribution to the story purpose.	The digital story has limited editing effects; the story materials are not well-organised making little contribution to the story purpose.
Citing	Proper citing was made to associate information with a source.	Some effort was made to cite information properly.	Little effort was made to cite information.	Failure to associate information with a source.

## APPENDIX II

### Focus group discussion protocol

Trial I focus group discussion protocol

Date:

Interviewer:

Participants:

Expected time: 20'

#### Rapport building:

- Greetings, purpose, format and structure of the discussion
- Data management and analysis
- Withdraw policy

#### Open-ended discourse:

1. What was your digital story about? Why did you choose this inquiry question?
2. Was the hand-out useful?
3. Was the storyboard useful?
4. How easy or difficult was it to do the museum investigation for your digital story?
5. How did you do the research?
6. How did you do your digital story?
7. Did the fact that you were researching for a digital story help you? In what ways?
8. Which was the most useful digital storytelling activity, and which one was the least useful for your museum investigation?
9. What about the mobile devices?
10. What about group work?
11. If I asked you to do another digital story, what would you do differently? Why?
12. Do you have any suggestions on how to improve the framework?
13. Did you enjoy taking part in the project? Why?

#### Wrap-up:

- Do you have any questions you would like to ask me?
- Thank you for your time

## APPENDIX III

### Hand-out



Your group has a "source of information." What can you learn from it, and what does it tell you? Examine your 'source' closely, discuss each point with your group and answer the questions as best you can. Put a "y" next to the categories of information to which you have access. Where possible, provide some support or reasoning for your action, and indicate 'not available' or 'not known' if appropriate.

Properties of an Object		How to Read an Object	
Questions to ask and answer		Observe, Deduce and Infer	
<b>Function/Purpose</b> What is it?	What is it called? What is or was it used for? Does it have more than one function? How has its use changed over time? Does it		What you can find out by looking closely at the object?
<b>Physical Features</b> What does it look and feel like?	How big is it? What's its shape, smell, and sound? What color is it? Is it complete? Has it been altered, adapted, or mended? Is it worn? What's the surface like? Does it have identifying numbers? Are there markings or writing on it? What's it made of? How many kinds of materials is it made of?		
<b>Materials</b>			
<b>Construction/Technique of Manufacture</b> How was it made?	Who made it? How was it made? Is it hand or machine made? Does it have parts? What does it tell you about the maker's technical skill?		

Adapted by the US National Park Service, Museum Management Program from the Hands on History Program, National Museum of American History, Smithsonian Institution, Washington, DC; Museum Magnet Schools, Education Resources, English Heritage, A Teacher's Guide to Learning from Objects; and the Victoria and Albert Museum education materials, London, England.

Properties of an Object Questions to ask and answer		Observe, deduce and infer What you can find out by looking closely at the object
<b>Design and Decoration</b> Does the design suit its purpose?	Were the best materials used? How is it decorated? What influenced its design and appearance?	
<b>Context and History</b> What can the object tell us about the society in which it was made?	When was it made? Where was it made? Where was it used? Where was it found? Who made it? Who used it? Who owned it? How has it changed over time? How does it compare to similar items from other cultures and time periods?	
<b>Value</b> How was it valued?	What kind of value did it or does it have: monetary, spiritual, aesthetic, sentimental, and practical: To the person/people who made it? To the person/people who used it? To the people who keep it? How has the object's meaning changed over time? How does the object reflect the person, community, nation or culture at the time it was made? How does the object expand your knowledge of the period?	

What else would have been helpful to complete your investigation?

Adapted by the US National Park Service, Museum Management Program from the Hands on History Program, National Museum of American History, Smithsonian Institution, Washington, DC; Museum Magnet Schools, Education Resources, English Heritage, *A Teacher's Guide to Learning from Objects*; and the Victoria and Albert Museum education materials, London, England.

## APPENDIX IV

### Intervention Power Point presentation (trial 1)

1

**Project: Digital storytelling for inquiry-based museum learning**

The efficacy of digital storytelling to facilitate students' inquiry learning in the ethnographic museum FEMMTH

at Pinewood the American International School

with Grade 8 in the Art History subject

Dates: 14/10/16, 21/10/16, 01/11/16 & 04/11/16

University of Leicester

2

The study expectations:

- fill-in the questionnaire about your research skills
- go through the steps of the inquiry-based learning and the digital storytelling processes
- explore the museum's exhibition and take notes of what is interesting
- use the hand-out to help you develop your own questions that will be answered through an investigation
- use the storyboard to plan the digital story that will present us the answers to your questions in the form of a video
- use your mobile digital devices to explore the museum content and collect and/or create story materials according to your inquiry and story plans
- analyse, organise and synthesise the information collected during the museum visit to edit and export your digital story as a video
- fill-in the questionnaire about your research skills
- take part in a focus group discussion to talk about your learning experience

University of Leicester

3


The stages of the inquiry-based learning process:

Questioning	Explore/task
	Plan investigation
Information gathering, analysis and inference	Collect and/or create information
	Analyse/interpret/synthesise
Reflection	Present/report
	Reflect/discuss

University of Leicester

4

Becoming a museum inquirer at the:

 **FOLKLIFE & ETHNOLOGICAL MUSEUM OF MACEDONIA-THRACE**

Use the hand-out to help you develop questions of personal interest, which will require an investigation in the museum to be answered.

Think of:

- what do I know already?
- what do I want to know?
- what do I want to tell in my story?
- how will I tell my story?





During the museum investigation ensure you keep records of sources.

University of Leicester

5

The exhibition content:

The water-powered mechanisms of the pre-industrial era used in Macedonia and Thrace were: **water/grist mills, water sawmills** (crankshafts), **cloth finishing waterfalls** and **fulling mills** (camshafts/**mantania**)

Εκ. 76: Συνεργαστήριο για το pulkithergia

University of Leicester

6

The development of farming and agriculture:

At the beginning, people used to eat seeds raw, dry or half roasted.

Then people thought about grinding them using flat stones.

Soon after people invented the 'roudi' and some one came up with the idea of the rotating mill.

People turned the seeds into flour uniformly some time in the early 5<sup>th</sup> century B.C.

Soon they started using animals to operate the mills as they had greater muscular strength comparing to people.

7

The water-powered mechanisms replaced the hand tools and people exploited the hydraulic energy for food, clothing and shelter.

The hydraulic energy:


- the kinetic energy (motion): produced from the natural flow of water as it is disposed
- the dynamic energy (power): produced when the heights difference in the water's surface is reduced with a waterfall

In the pre-industrial Greece around 30.000 hydraulic mechanisms were operated.



In Macedonia and Thrace, the use of water-powered technology spread in the 19<sup>th</sup> century and the early part of the 20<sup>th</sup> century.

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8



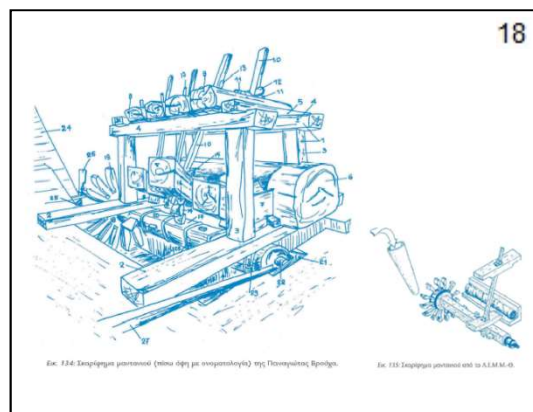
Εκ. 160: Ορόσημα νερόμυλου στο Λ.Ε.Μ.Μ.-Θ.










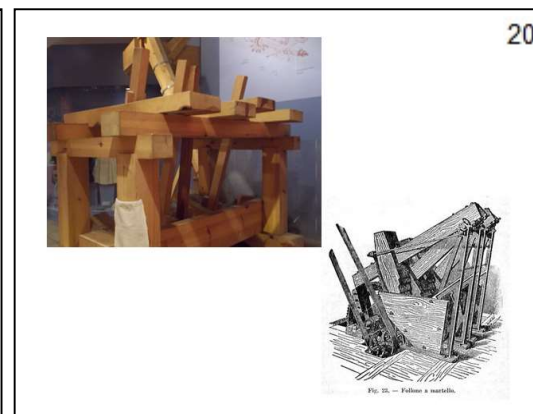
**19**

Fulling mills/Camshafts:

The fulling mill was introduced into Greece in the 19<sup>th</sup> century and it was used to turn raw wool first into yarn and then into cloth which was firmer, waterproof and more durable. The four hammers of the fulling mill rhythmically beat the wet twill until the weave tightens, the surface naps and the cloth firms up.

It is made out of three parts: the axle which is attached to the wooden wheel, the main turning device with its wooden blocks and the peripheral set of blocks which move the hammers which beat the cloth that goes in between.






**21**

The stages of the digital storytelling process:

Planning	Set a story idea
	Storyboarding
Production	Collect and/or create information
	Synthesis/edit
Reflection	Share/watch
	Reflect/discuss




**22**

The ten elements of a digital story:

- a purpose
- a point of view
- a dramatic question
- the choice of content
- the clarity of voice
- pacing
- the use of audio soundtrack
- the quality of images, video and effects
- the economy of details
- the proper use of grammar and language (Robin and Pierson, 2005).

Use the storyboard to organise and visualise what would work for your digital story or not.




**23**

Prepping for the museum visit :

Don't forget to bring with you:

1. Your hand-outs and your storyboards
2. Your smartphones and tablets
3. Chargers and (if needed) cables to transfer items to your group's Google Drive folder back to school
4. Packed lunch

During your staying at the museum's premises please keep your voices low. No running and rough play inside the museum. Taking photographs of the exhibited content is allowed. No flash.



**24**


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## APPENDIX V

### Lesson plan (trial 1)

Trial I pre-visit lesson 1

Date: 14/10/16

Subject: Art History Grade 8

Number of students: 26

Session objectives (students will):

1. Complete the pre-visit research skills questionnaire
2. Be reminded of what the inquiry-based learning process entails and work in groups of 3 to develop a researchable question using the hand-out
3. Become cognisant of the exhibition's content, observe and take notes

Intended outcomes (students will be able to):

1. Demonstrate conceptual understanding of the inquiry-based learning process
2. Show general conceptual understanding of the exhibition's content

Time: 60'

Warm-up session: The students will fill-in the pre-visit research skills questionnaire.

Work session: The students will be reminded of what the inquiry-based learning process entails using illustrative examples. Then the researcher will present the FEMMTH's permanent exhibition. The students will work in groups of 3 to develop a researchable question using the hand-out.

Wrap-up session: The researcher will prompt a brief group discussion to immerse the students into the content.

Skills addressed:

- visual arts standards
- study skills
- language arts standards
- social skills

Anticipated difficulties and solutions:

- Problem: students might be confused about what they are doing or might be hesitant to apply their prior knowledge to the new context  
Solution: clear instructions to be given and monitor the students' understanding regularly

## APPENDIX VI

### NVivo 11 Pro © nodes

Name	Sources	References	Created By	Created On	Modified By	Modified On
Activities	0	0	UOL	11/02/2018 23:04	UOL	11/02/2018 23:11
CL	214	286	UOL	11/02/2018 23:04	UOL	28/05/2018 10:58
EV	99	137	UOL	11/02/2018 23:12	UOL	28/05/2018 15:45
RA	48	83	UOL	11/02/2018 23:12	UOL	28/05/2018 15:44
RT	175	210	UOL	11/02/2018 23:12	UOL	28/05/2018 15:43
RV	44	67	UOL	11/02/2018 23:12	UOL	27/05/2018 12:39
TE	48	73	UOL	11/02/2018 23:12	UOL	27/05/2018 12:44
TP	131	195	UOL	11/02/2018 23:12	UOL	28/05/2018 15:45
UH	65	69	UOL	12/02/2018 13:40	UOL	28/05/2018 09:15
Helpful	1	8	UOL	12/02/2018 13:41	UOL	27/05/2018 12:46
Not helpful	1	6	UOL	12/02/2018 13:42	UOL	27/05/2018 14:46
Not used	0	0	UOL	12/02/2018 13:42	UOL	12/02/2018 13:42
UK	78	116	UOL	12/02/2018 13:26	UOL	28/05/2018 15:40
UP	155	191	UOL	11/02/2018 22:53	UOL	28/05/2018 15:45
Easy to use	6	21	UOL	11/02/2018 23:30	UOL	27/05/2018 17:49
Not easy to use	0	0	UOL	12/02/2018 01:05	UOL	12/02/2018 01:05
Lack of storage	1	2	UOL	11/02/2018 23:31	UOL	19/05/2018 12:32
Problems with app & Solutions	2	8	UOL	11/02/2018 23:30	UOL	27/05/2018 12:43
US	102	104	UOL	11/02/2018 22:49	UOL	28/05/2018 15:44
Helpful	7	34	UOL	11/02/2018 22:58	UOL	27/05/2018 13:09
Not helpful	4	6	UOL	11/02/2018 22:58	UOL	27/05/2018 17:35
Not used	2	6	UOL	11/02/2018 22:58	UOL	27/05/2018 17:35
UT or laptop	225	233	UOL	11/02/2018 22:53	UOL	28/05/2018 15:45
Easy to use	5	10	UOL	11/02/2018 23:30	UOL	27/05/2018 17:48
Not easy to use	0	0	UOL	12/02/2018 01:05	UOL	12/02/2018 01:05

Lack of storage	1	1	UOL	11/02/2018 23:35	UOL	12/02/2018 16:26
Problems with app & Solutions	4	8	UOL	11/02/2018 23:31	UOL	27/05/2018 17:51
WT	168	249	UOL	11/02/2018 23:09	UOL	28/05/2018 15:25
CF	0	0	UOL	12/02/2018 13:21	UOL	12/02/2018 13:23
Demonstrating	7	7	UOL	12/02/2018 13:22	UOL	10/03/2018 20:22
Q&A	4	4	UOL	12/02/2018 13:22	UOL	27/05/2018 14:39
CN	0	0	UOL	11/02/2018 22:43	UOL	27/05/2018 16:52
Details about DS	14	30	UOL	11/02/2018 22:44	UOL	27/05/2018 17:40
Reason for INQ	13	48	UOL	11/02/2018 22:43	UOL	27/05/2018 17:41
DS helps for INQ	8	51	UOL	11/02/2018 22:54	UOL	27/05/2018 17:47
Least helpful activity (and why)	12	31	UOL	11/02/2018 23:25	UOL	27/05/2018 17:47
Most helpful activity (and why)	12	44	UOL	11/02/2018 23:25	UOL	27/05/2018 17:53
Neutral	8	12	UOL	11/02/2018 22:55	UOL	27/05/2018 16:59
No (and why)	7	21	UOL	11/02/2018 22:54	UOL	27/05/2018 17:41
Yes (and why)	14	135	UOL	11/02/2018 22:54	UOL	27/05/2018 17:50
Group name	0	0	UOL	11/02/2018 22:26	UOL	11/02/2018 23:52
AC (Alabama Crimson)	36	171	UOL	12/02/2018 13:27	UOL	19/05/2018 10:53
AD (Almond)	33	95	UOL	12/02/2018 13:28	UOL	19/05/2018 11:19
AG (Aztec Gold)	24	33	UOL	08/02/2018 12:59	UOL	23/02/2018 19:37
AL (Alabaster)	14	24	UOL	08/02/2018 12:56	UOL	23/02/2018 19:02
AM (Amazonite)	26	30	UOL	08/02/2018 12:58	UOL	23/02/2018 19:40
AO (Alloy Orange)	19	81	UOL	12/02/2018 13:31	UOL	28/05/2018 15:41
AP (Amaranth Purple)	17	17	UOL	08/02/2018 12:58	UOL	19/02/2018 22:20
AR (Artichoke)	31	122	UOL	12/02/2018 13:28	UOL	19/05/2018 12:17
AT (Atomic Tangerine)	18	31	UOL	08/02/2018 12:58	UOL	23/02/2018 19:41
AU (Azure)	18	142	UOL	12/02/2018 13:32	UOL	28/05/2018 15:40
AY (Arylide Yellow)	23	105	UOL	12/02/2018 13:31	UOL	28/05/2018 15:41
AZ (Absolute Zero)	13	38	UOL	12/02/2018 13:31	UOL	28/05/2018 15:37
BB (Beau Blue)	18	58	UOL	12/02/2018	UOL	28/05/2018

				13:32		15:45
BE (Begonia)	22	94	UOL	12/02/2018 13:32	UOL	28/05/2018 15:45
BG (Battleship Gray)	14	25	UOL	08/02/2018 13:00	UOL	19/02/2018 22:11
BI (Bistre)	19	85	UOL	12/02/2018 13:32	UOL	28/05/2018 15:44
BM (Bright Maroon)	11	14	UOL	08/02/2018 13:00	UOL	19/02/2018 22:17
BR (British Racing Green)	18	22	UOL	08/02/2018 13:00	UOL	19/02/2018 22:12
BS (Brass)	27	104	UOL	12/02/2018 13:28	UOL	27/05/2018 11:30
BU (Burnt Umber)	21	33	UOL	08/02/2018 13:01	UOL	19/02/2018 22:17
BY (Burgundy)	33	180	UOL	12/02/2018 13:28	UOL	27/05/2018 11:51
BZ (Bronze)	21	21	UOL	12/02/2018 13:32	UOL	28/05/2018 15:44
GW	314	349	UOL	11/02/2018 22:50	UOL	28/05/2018 15:45
IW	85	85	UOL	11/02/2018 22:51	UOL	28/05/2018 15:40
RF	0	0	UOL	12/02/2018 13:24	UOL	12/02/2018 13:24
Demonstrating	2	2	UOL	12/02/2018 13:24	UOL	10/03/2018 20:54
Q&A	8	8	UOL	12/02/2018 13:24	UOL	09/03/2018 10:58
SF	0	0	UOL	12/02/2018 13:25	UOL	12/02/2018 13:25
Demonstrating	2	2	UOL	12/02/2018 13:25	UOL	27/05/2018 12:24
Q&A	7	36	UOL	12/02/2018 13:25	UOL	27/05/2018 12:43
Trial	0	0	UOL	12/02/2018 13:09	UOL	12/02/2018 13:26
Trial I	126	199	UOL	12/02/2018 15:17	UOL	09/03/2018 10:17
Trial II	133	667	UOL	12/02/2018 15:17	UOL	27/05/2018 11:51
Trial III	143	617	UOL	12/02/2018 15:17	UOL	28/05/2018 15:45
What would you do differently	0	0	UOL	11/02/2018 22:49	UOL	11/02/2018 22:49
App training	1	1	UOL	11/02/2018 23:42	UOL	12/02/2018 16:30
Better group work	2	3	UOL	11/02/2018 23:40	UOL	27/05/2018 12:48
Better organisation	7	16	UOL	11/02/2018 23:40	UOL	27/05/2018 17:38
Different topic	4	14	UOL	27/05/2018 12:47	UOL	27/05/2018 17:43
Less - Better writing	6	20	UOL	19/05/2018 11:50	UOL	27/05/2018 17:32
Less waiting time	1	1	UOL	15/05/2018 11:34	UOL	15/05/2018 11:34
More websites	5	19	UOL	27/05/2018	UOL	27/05/2018

				13:13		17:46
No changes	5	7	UOL	11/02/2018 23:41	UOL	27/05/2018 17:53
Record without background noise	2	3	UOL	15/05/2018 11:28	UOL	27/05/2018 17:37
See DS in advance	1	3	UOL	27/05/2018 14:48	UOL	27/05/2018 14:48
Take more photos	7	24	UOL	15/05/2018 11:23	UOL	27/05/2018 17:47
Take more time	9	26	UOL	11/02/2018 23:19	UOL	27/05/2018 17:52
Use another app	6	16	UOL	11/02/2018 23:41	UOL	27/05/2018 17:51
Visit physically museum	1	2	UOL	27/05/2018 16:31	UOL	27/05/2018 16:31
Whole evaluation of experience	0	0	UOL	11/02/2018 23:34	UOL	11/02/2018 23:34
Negative	3	6	UOL	11/02/2018 23:34	UOL	27/05/2018 14:49
Neutral	5	11	UOL	11/02/2018 23:34	UOL	27/05/2018 17:01
Positive	14	68	UOL	11/02/2018 23:34	UOL	27/05/2018 17:54

## APPENDIX VII

### Observation form

#### Observation form

Date:

Number of students:

Mark a line in the tally column each time you observe behaviour and/or an activity close to the one sought.

<b>Planning</b> (level of students' preparation):	Tally
Students understand the purpose and requirements of the task.	
Students have their mobile devices with them and know how to use them.	
<b>Interaction</b> (what are the students doing and why):	Tally
Students behave properly according to the museum rules.	
Students can navigate themselves in the museum space.	
Students locate resources easily.	
Students observe the exhibited content carefully.	
Students collect information (note-taking/taking photographs).	
Students create information (writing/sketching/audio/video recording).	
Students filter and organise the collected information.	
Students keep records of what they find for referencing.	
Students use the mobile devices effectively.	
Students work well in groups and provide feedback.	
Students show increased involvement/engagement.	
Students can assess the collected information, determine what information is useful and discount the unnecessary.	
Students apply pre-visit knowledge in context.	
Students demonstrate good time management skills.	
Students synthesize ideas to form a coherent argument.	
Students draw conclusions based on their observations and analysis.	
Students look for alternative ways to problem-solving.	

## APPENDIX VIII

### Parent project information sheet

Trial I parent's project information sheet

#### Title of the research study:

*The efficacy of digital storytelling to facilitate students' inquiry-based learning in the museum*

#### Invitation:

Your child for whom you are the parent/guardian has been invited to take part in the project *The efficacy of digital storytelling to facilitate students' inquiry-based learning in the museum* which is research towards a doctoral degree at the University of Leicester, United Kingdom. Your child's teacher has understood the purpose and procedure, risks and benefits of this study and has signed a consent form for the class's participation. Your child's participation in this study is entirely voluntary. Your child has been given a project information sheet and signed a voluntary participation consent form. Your child has the right to withdraw with no penalty or loss of benefits any time before, during and within the period of *five months after* the last session of the study without having to give a reason. Before you decide on your child's participation, it is important for you to understand why this study is being done and what it involves. Take enough time to read the following information carefully.

#### Purpose of the research study:

This research study will help me understand how digital storytelling supports inquiry-based learning in the museum. Your child's participation will help me gain more knowledge on the use of digital storytelling as a facilitator to student-initiated and student-run learning enabled by mobile devices. Your child's data will be used to examine how s/he benefited from crafting digital stories as part of his/her work on inquiry tasks as a *detective* inside the museum.

#### A few words about me:

My name is Zoi Tsiviltidou and I am a PhD student at the School of Museum Studies in the University of Leicester, United Kingdom. I am carrying out this research study because I want to find out more about digital stories in museum education and understand how students like yours make sense of the learning experience when they use mobile devices to explore and investigate in the museum what interests them the most, and when they tell their own stories about their experience.

#### Research phases:

##### In Phase One

Students will attend two classroom-based sessions where they will be introduced to the learning process of the intervention and to the museum's exhibition. They will fill-in a



questionnaire about their research skills and be asked to work on planning and determining what needs to be known and how for their investigations during the museum visit.

#### In Phase Two

Students will take part in the organised school visit to the ethnographic museum where they will engage in inquiry-based activities to search for information for their digital stories. They will need to **bring their own mobile devices** to engage in material exploration, observe, and take notes and photographs, record sounds as well as their own voices. I will be monitoring them working during the visit (estimated time 2 hours) and the intent of my note-taking will be to observe their behaviour and activities.

#### In Phase Three

Students will attend one classroom-based session where they will refine what they have collected during their museum visit, edit and complete their digital stories. They will fill-in a questionnaire about their research skills. Later, they will take part in a focus group discussion where I will elicit their perspectives and informed opinions of whether they benefited and to what extent from the activities.

#### Confidentiality and protection of personal data:

This research study has been approved by the University of Leicester and complies with the Code of Ethics of the School of Museum Studies, University of Leicester, United Kingdom. All information your child will provide during the course of the study will be treated according to the Hellenic Data Protection Authority Guidelines and the relevant UK Guidelines including the Data Protection Act 1998 and will be kept confidential. All data records from this study will be kept secure in a password-protected computer with data encryption. The data your child provides will be stored for seven years after the submission of the thesis. Participant names will not be disclosed. Instead, pseudonyms will be used to refer to individual children in order to protect children's anonymity. The research findings will be presented in the thesis and other academic publications including on the Internet. If you have any concerns about the ethics of this research please contact the Ethics Officer, Dr Giasemi Vavoula, by email: [gv18@le.ac.uk](mailto:gv18@le.ac.uk) or telephone: (+44) 1162523866.

#### Researcher's contact details:

Zoi Tsiviltidou, PhD student, School of Museum Studies, University of Leicester, 19 University Road, Leicester, LE1 7RH, United Kingdom, email address: [zt30@le.ac.uk](mailto:zt30@le.ac.uk), telephone: (+44)1162523963.

If you have a question later that you did not think of now you can contact me via email.

Thank you for reading this leaflet. I hope you allow your child to take part in the study.

## APPENDIX IX

### Parent voluntary participation consent form

Trial 1 parent's voluntary participation consent form

I agree that my child participates in the study project *The efficacy of digital storytelling to facilitate students' inquiry-based learning in the museum* which is research towards a doctoral degree at the University of Leicester, United Kingdom.

I have had the project explained to me and I have read the Project Information Sheet about the study which I may keep for my records. I understand that this study project will be carried out in accordance with the University of Leicester's Code of Research Ethics which can be viewed at <http://www2.le.ac.uk/institution/ethics/code>. Material my child provides for the study will be treated as confidential and securely stored in accordance with the Hellenic Data Protection Authority Guidelines and with the relevant UK Guidelines including the Data Protection Act 1998.

Questions:	Yes	No
1. I have read, and I understand all the information about the study given to me on the project information sheet.		
2. I understand that my child's participation is entirely voluntary, and s/he may withdraw at any time up to five months after the last session of the study without having to give a reason.		
3. My child for whom I am the parent/guardian has been informed in writing about the purpose and procedure, risks and benefits of the study and s/he has been consented to take part by signing his/her name.		
4. I understand that my child's real name will not be used in any form of writing and his/her details will be kept confidential.		
5. I understand that data my child may provide for this study will be treated as confidential, securely stored for seven years after thesis submission, and will be used by the researcher for writing the thesis and other academic publications.		
6. I agree my child to take part in the classroom-based sessions and the museum visit and to be observed by the researcher.		
7. I am willing to allow the researcher to interview my child and his/her words to be audio-recorded and transcribed.		
8. I was given enough time to read the project information sheet carefully and make an informed decision about my child's participation.		

#### Consent:

Signing my name at the bottom of this form means that I agree my child to take part in this study. I will be given a copy of this consent form after I have signed it to keep for myself.

\_\_\_\_\_  
Parent/Guardian

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

## APPENDIX X

### Risk assessment for the museum visit

Trial I risk assessment for the museum visit

Date of the activity: 1/11/16		Assessed by:		Location: FEMMTH	
<u>Description of activity:</u> Pinewood International School Museum Visit - Grade 8					
People at risk: students, teachers, museum staff, general public					
<u>Hazard:</u>				Risk rating: (LxS=R)	
		Likelihood		Severity	Risk
1. Road journey accident		1		3	2
2. Accident when on coach		1		2	1
3. Misbehaviour in the museum		3		1	2
4. Losing students in the museum		1		1	2
5. Accident in the museum (slips, trips, falls)		1		2	2
6. Weather		1		1	1
7. Damage to the museum's property		2		1	2
8. Coach late at the pickup point (come & go)		3		1	2
9. Illnesses (allergic reaction, exhaustion, dehydration)		1		2	2
10. Malfunction of or damage to the mobile digital technologies		3		1	2
11. Failed Internet connection		3		1	1
12. Toilets (minor injuries or unsupervised interaction between students and others)		2		2	1
13. Fire in the museum		1		3	2
Likelihood	Very unlikely = 1	Unlikely = 2	Likely = 3	Very likely = 4	Certain = 5
Severity	Minor injury = 1	Minor inquiry that requires First Aid = 2	Serious injury = 3	Likely death/ serious injury= 4	Certain death = 5

#### Precautions taken for risk aversion:

1. Ensure the coach has valid vehicle insurance and a first aid kit on board.
2. Reinforce coach rules before and during the trip, students will always be seated and wear seatbelts, teachers to check on them regularly.
3. Remind students of school visit museum rules issuing merits/demerits. Teachers to go over the school visit museum rules with the students.
4. Students to be made clear where the meeting point is at all times and to be made aware of the time allocated to each activity, teachers to have each other's mobile phone numbers, headcounts to be made each time when we get on & off the coach and before and after leaving the museum.

5. Teachers should never leave students unattended; teachers be made aware of the location of the first aid kit available in the museum and have a list of contact emergency phones in hand. No running inside the museum.
6. Bring appropriate clothing for change in the weather (e.g. raincoat and/or umbrella).
7. Make sure students know the school visit museum rules, teachers to monitor their behaviour regularly and maintain a calm and supportive environment.
8. Teachers to have the driver's contact phone number, students stay together in groups, crossing of roads will only happen at zebra crossings supervised.
9. Teachers to monitor students and look for symptoms of exhaustion, dehydration or allergies during the journey and the museum visit.
10. Have a spare device and extra batteries, pilot-test them.
11. Check signal and connectivity of the Internet provider upon arrival to the museum.
12. Teachers to supervise students in toilets, students always go for toilet breaks in pairs.
13. Teachers to be aware of the fire exits in the museum. Never use lifts in the event of fire. Gather all students, follow the instructions from staff and calmly leave the premises.

Review of hazard (if all risk aversion advice is followed):		Risk rating: (LxS=R)	
	Likelihood	Severity	Risk
1. Road journey accident	1	2	1
2. Accident when on coach	1	2	1
3. Misbehaviour in the museum	2	1	2
4. Losing students in the museum	1	1	1
5. Accident in the museum (slips, trips, falls)	1	2	1
6. Weather	1	1	1
7. Damage to the museum's property	1	1	2
8. Coach late at the pickup point (come & go)	3	1	2
9. Illnesses (allergic reaction, exhaustion, dehydration)	1	2	1
10. Malfunction of or damage to the mobile digital technologies	2	1	2
11. Failed Internet connection	2	1	1
12. Toilets (minor injuries or unsupervised interaction between students and others)	1	2	1
13. Fire in the museum	1	3	1
Further recommendations:			

\_\_\_\_\_  
Assessor(s)

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date:

## APPENDIX XI

### School director consent form

#### School director consent form

I hereby give consent to Zoi Tsiviltidou to approach students to participate in the research project *The efficacy of digital storytelling to facilitate students' inquiry-based learning in the museum*.

I have read the Project Information Statement explaining the purpose of the research project and I understand that:

- The participation of the school is entirely voluntary.
- Students will be invited to participate, and permission will be sought from them in written form.
- Only students who consent will participate in the study.
- All information and data obtained from students will be treated in confidence.
- The students' names will not be used, and individuals will not be identifiable in any written work about the study.
- Participants may withdraw from the study within five months after the completion of the study without penalty and with a prior notice.
- I may seek further information on the project from Zoi Tsiviltidou or her supervisor Dr Giasemi Vavoula via email or telephone and their contact details were provided to me.

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School Director

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Signature

---

Date

## APPENDIX XII

### **School director letter of invitation**

#### Letter of invitation

From:

Date: 08 June 2016

Zoi Tsiviltidou

PhD student

School of Museum Studies

University of Leicester

19 University Road, Leicester

LE1 7RH United Kingdom

To:

Dr Roxanne Giampapa

School Director

Pinewood - The American International School of Thessaloniki

14<sup>th</sup> km Thessalonikis - N. Moudanion, Thermi, Thessaloniki

57001 Greece

Dear Roxanne Giampapa,

I am a registered PhD student in the School of Museum Studies in the University of Leicester and I am conducting research about the educational use of digital storytelling as a frame for students' inquiry-based learning in the museum under the supervision of Dr Giasemi Vavoula, Lecturer and Ethics Officer, and Dr Ross Parry, Senior Lecturer and College of Art, Humanities and Law Academic Director, at the University of Leicester, United Kingdom.

The title of my research project is 'The efficacy of digital storytelling to facilitate students' inquiry-based learning in the museum' and the principal aim is:

- To examine how does digital storytelling facilitate students' inquiry-based learning for research skills development in the museum;
- And if yes, which are the benefits, and which are the limitations?

I am hereby seeking your consent to conduct research during the academic year 2016-2017 with class sessions at your school and museum visits in Thessaloniki, Greece. The data collection tools are note-taking, student questionnaires, observations, photographs, a focus group discussion, student group interviews and teacher interviews. Permission will be sought from the students prior to the start of the study. Only those who consent will participate. I will run the intervention sessions, administer the questionnaires to the students and I will be the

sole conductor of the interviews. All information collected will be treated in confidence and no individuals will be identifiable in any work written. Research participants may withdraw from the study within five months after the completion of the study with prior written notice to the researcher.

This research study will help me understand how digital storytelling supports students' inquiry-based learning in the museum. Your school's participation will help me gain more knowledge on the use of digital storytelling as a facilitator to student-initiated and student-run learning enabled by mobile devices. Your students' data will be used to examine how they benefited from crafting their own digital stories as part of their work on inquiry tasks as *detectives* inside the museum.

To assist you reaching a decision, I can provide you with:

- a copy of the data collection tools which I intend to use during the study
- a copy of the ethical clearance certificate once issued by the Ethics Committee
- a copy of the student participant information sheet and voluntary consent form

Should you require any of the above or any further information, do not hesitate to contact me or my supervisor via email. Our contact details are as follows:

Zoi Tsiviltidou, PhD student, School of Museum Studies, University of Leicester, 19 University Road, Leicester, LE1 7RH United Kingdom, email address: [zt30@le.ac.uk](mailto:zt30@le.ac.uk) and telephone: (+30) 6976107938.

Dr Giasemi Vavoula, Lecturer and Ethics Officer, School of Museum Studies, University of Leicester, 19 University Road, Leicester, LE1 7RH United Kingdom, email address: [gv18@le.ac.uk](mailto:gv18@le.ac.uk) and telephone: (+44) 1162523866.

If you would like your school to participate in this research project, please complete the consent form that follows the letter of invitation.

Your permission to conduct this research study will be greatly appreciated.

Yours truly,  
Zoi Tsiviltidou

## APPENDIX XIII

### Storyboard

Digital storytelling storyboard -adapted from Jason Ohler's template (2010)

What is my group's inquiry question?	Which is my point of view?	What emotions do I want people to feel?
Picture frame here:	Picture frame title and explanation:	Audiovisuals/effects (type/explanation):
Script:		
Picture frame here:	Picture frame title and explanation:	Audiovisuals/effects (type/explanation):
Script:		



## APPENDIX XIV

### Student group interview transcript (trial 3)

The interview was transcribed using InqScribe ©.

Trial III interview with the Arylide Yellow group

[00:00:00]Researcher: What was your digital story about?

ArylideYellow1: Our story was about the owner who had a factory and a woman and the children who were working there. Basically, he was talking with the woman what is all like to be working like that, how it's the situation, the characters and their lives.

Researcher: Why did you choose this?

ArylideYellow1: We knew about the Victorian Era before. So, we knew about the child labour and the woman abuse in the factory. So, we chose to talk about that and search more about the situation to show how it was.

Researcher: Search more?

ArylideYellow1: Yes. Yeah, do a lot of research.

ArylideYellow2: Yes.

Researcher: How easy or difficult was it to do the museum research for your digital story?

ArylideYellow1: It was difficult to find photos appropriate for our story.

ArylideYellow2: Yeah, because the website didn't have the photos that we needed.

Researcher: So, you didn't find what you wanted in the museum archives?

ArylideYellow2: Not all the photos.

ArylideYellow1: Yeah, we didn't find all the photos. There were photos of the objects basically. But they didn't have the photos that we needed.

Researcher: So, what did you do?

ArylideYellow2: Look for more in another website.

ArylideYellow1: Find them in another website.

Researcher: Tell me about that.

ArylideYellow2: We found them in Pinterest.

ArylideYellow1: Pinterest, yeah. And we were searching for the photos that were about that time and we found some that were interesting, and we could use to illustrate our story.

ArylideYellow2: Yeah.

Researcher: OK. Did the fact that you had a focus on your research, because you were looking for specific photos to illustrate your story, helped you with your research?

ArylideYellow2: I think it is better like when you're looking at specific things, for things you really know what to do with.

ArylideYellow1: Yeah, it's better when you're looking at specific photos. Because then you google it and basically there is the website that pops up and they are talking about that specific thing. If you're browsing everything like in all the collections then you would have to spend a lot more time to research for things.

Researcher: Tell me about writing your script.

ArylideYellow1: Writing the story? Once we saw the photos, we had an idea what it is going to look like so...

ArylideYellow2: We started writing the script.

ArylideYellow1: Yeah, we started writing the script.

Researcher: Tell me about that.

ArylideYellow1: We had an idea of how the owner would behave and how he would talk and how the woman responds. So, we kind of got into the shoes of the owner and the people that were working in the factory. That's how we could write the script.

Researcher: How?

ArylideYellow1: We had an event. We had some focus like main event of what's going on and what will happen. So, based on that we were developing the script.

ArylideYellow2: Yeah.

Researcher: How was the recording of the script?

ArylideYellow2: It was difficult. Because we needed to repeat it a lot of times to get it rolling, to have like the perfect voice.

ArylideYellow1: Yeah, to get into the actual soul of whoever like was talking. So, whoever watched our movie he can imagine what was going on in their lives. He can picture it in like the tone of the voice.

Researcher: The tone of the voice?

ArylideYellow1: Yeah, yeah, the tone of the owner, of the woman, of the different people.

Researcher: For their feelings?

ArylideYellow2: Yes, yes.

ArylideYellow1: Yeah, yeah.

Researcher: How about the editing? You used i-Movie.

ArylideYellow2: Yeah, we used i-Movie.

Researcher: Tell me about that.

ArylideYellow1: It was hard to do. Because the first time we did it, we put all the recordings and then once we tried to edit and to make it better, it kind of got separated. And we could not bring it back because there was some I don't know some problem that we couldn't solve. So, we had to delete everything and put everything again inside.

Researcher: How did you solve this problem?

ArylideYellow1: We deleted everything, and we put again the audio.

ArylideYellow2: And the photos again.

Researcher: Are you happy with your digital story?

ArylideYellow1: Yeah, yeah.

ArylideYellow2: Yes.

Researcher: Does it portray everything that you wanted to show?

ArylideYellow1: Yeah, it portrays everything. And I think it's interesting and fun to watch.

Researcher: Really?

ArylideYellow1: Yeah, yeah.

Researcher: Which digital storytelling activity helped you the most to look for what you wanted and which one the least to look for what you wanted?

ArylideYellow1: Ehm, the most helpful was the research for the photos. Because once we researched for the photos, we had an idea of what is going on in our story. And the least was like working on the script details. Because we did not know what is going to look like. But once we saw the photos, we knew what the script will be about. So, in the beginning we just wrote some ideas down. But later, we didn't use them because we found the photos and we had some better ideas.

Researcher: Was the storyboard helpful?

ArylideYellow1: We haven't done that.

Researcher: How did you do your planning?

ArylideYellow2: First, we chose the photos and then we wrote the script.

ArylideYellow1: Actually, we had like the order of the photos that we came up with. And with that order we were writing the script.

ArylideYellow2: Yeah, yeah.

ArylideYellow1: Is this what you're asking?

Researcher: Yes, how you did your planning.

ArylideYellow1: Alright, yes. We were doing that. But not like for every single picture like have a text to record. We didn't write it like that. The words that match. But like putting the photos in order with our ideas.

Researcher: For the sequence?

ArylideYellow1: Yeah, yeah.

ArylideYellow2: Yes, the sequence.

ArylideYellow1: Yeah, yeah. We had the sequence of the photos and then we did the script with details.

Researcher: What did you learn from the editing?

ArylideYellow1: Yeah, we learned some things we used about the i-Movie app and about to do the research for the story.

ArylideYellow2: i-Movie. How to do it with i-Movie.

Researcher: Do you think that your research skills improved?

ArylideYellow1: Yes, I think we had some better idea how to do the digital story with what we found out from the websites.

ArylideYellow2: Yeah, yeah.

ArylideYellow1: And if we do it again we will know the steps. And I think we will do better.

ArylideYellow2: Better, yeah.

ArylideYellow1: And we will not spend so much time on try to record the script and find what is going to happen, what the actions will be, the characters. We will not stop for the writing so much.

Researcher: To look for things?

ArylideYellow1: Yeah, exactly.

Researcher: Do you believe that you know how to do museum research better?

ArylideYellow2: Yes, now we learned how to do museum research. But with the website that you gave to us we didn't find like everything we wanted. But now we know how.

ArylideYellow1: Yeah, yeah.

Researcher: Do you know how to look for things in the museum archives, the websites?

ArylideYellow2: Yes, now we learned about it.

ArylideYellow1: Yeah, we kind of have a better idea. I don't think that we are like that good, but we have a better idea of it.

ArylideYellow2: Yes.

ArylideYellow1: We learned how to do museum research.

Researcher: You learned how to do museum research?

ArylideYellow2: Yes.

Researcher: If I asked you to do research for a digital story for another subject, what would you do differently?

ArylideYellow1: We would start first by picking all the photos. Find everything first.

ArylideYellow2: And then writing the script.

ArylideYellow1: We would start work with the research and then we would write the script.

ArylideYellow2: And we would choose maybe another program like maybe a program we understand better.

Researcher: Which one?

ArylideYellow2: Like for example Adobe Photoshop or something like this.

ArylideYellow1: Yeah, we would use Adobe Photoshop for the photos.

Researcher: What was the most exciting part and what was the least helpful part of the whole project?

ArylideYellow1: The most exciting was when we did the recording.

ArylideYellow2: Yes.

ArylideYellow1: And the least helpful was...

ArylideYellow2: Doing the script.

ArylideYellow1: Yeah, writing the details in the script.

ArylideYellow2: Yeah, writing everything.

ArylideYellow1: Yeah, that was the least helpful. Because we had to do it right.

Researcher: OK. Anything else that you would do differently? Any advice?

ArylideYellow1: To do research first and then write the whole script I think. Because once you do the research you know like what you have collected, and the questions are clear. And you know what you should make with your script. Once you see the photos, then you make the script right.

Researcher: How does that work?

ArylideYellow1: Ehm, you create focus you know like you have some main ideas like what the events are, what is going on and stuff. But you don't write the script before you pick all the photos. Because if you write the script first, it would take much more time to find the right photos.

ArylideYellow2: Yeah, to find all the photos.

ArylideYellow1: And the photos may not be the ones you wanted but the ones you needed for your script to match.

Researcher: OK. What about time?

ArylideYellow1: Time was good. We had time.

ArylideYellow2: Yeah, yeah.

Researcher: OK. Any questions?

ArylideYellow1: No.

Researcher: Did you enjoy the project?

ArylideYellow1: Yes.

ArylideYellow2: We enjoyed it. [00:10:34]

## APPENDIX XV

### Student post-visit research skills questionnaire

Trial I post-visit research skills questionnaire

Name: \_\_\_\_\_

#### Part One

Instructions: For each of the following questions, please, circle the answer you think comes closest to being true. Answer the questions in the order in which they appear.

1. What is your gender? Male / Female
2. What is your age? 12 / 13 / 14
3. Did you take part in the pre-visit session(s)? Yes / No
4. Did you take part in the museum visit session? Yes / No
5. Did you take part in the post-visit session(s)? Yes / No

#### Part Two

Instructions: For each of the following statements, please, tick the box with the response you think comes closest to the way you feel. There is no right or wrong response.

When thinking about my research skills:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
6. I like exploring interesting ideas.					
7. I am good at observing things and taking notes.					
8. I am good at asking questions about my observations.					
9. I am good at developing hypotheses.					
10. I am good at planning investigations.					
11. I know where to look for information to find an answer to a question and/or a solution to a problem.					
12. I know how to assess the relevance and accuracy of the information I find.					
13. I can compare and contrast ideas.					
14. I can run an experiment to test my hypotheses.					
15. I can analyse the research findings to understand the question/problem better.					
16. I can detect patterns of ideas in my analysis.					
17. I am good at synthesising ideas to form a coherent argument.					
18. I am good at drawing conclusions based on my observations and/or experiments.					
19. I am willing to look for alternative ways to solve a problem/find an answer to a question.					

20. I always take calculated risks.					
21. I am good at time management and I can prioritise effectively.					
22. I can adapt to change.					
23. I know how to cite people's work when I use it.					
24. I am good at presenting my research findings to others.					
25. I work better in a group than on my own.					
26. I am happy to think about what worked well during my investigation and what did not work as planned.					
27. I am happy to receive feedback.					
<b>When thinking about the museum visit:</b>	<b>Strongly disagree</b>	<b>Disagree</b>	<b>Neither agree nor disagree</b>	<b>Agree</b>	<b>Strongly agree</b>
28. The mobile devices helped me collect all the information I needed for the digital story.					

### Part Three

Instructions: For each of the following questions, please, write your answer in the box below each question. Answer the questions in the order in which they appear.

29. Which digital storytelling activity did you find the most useful for your investigation and why?

30. Which digital storytelling activity did you find the least useful for your investigation and why?

Thank you!

## APPENDIX XVI

### Student project information sheet

Trial I student's project information sheet

#### Title of the research study:

*The efficacy of digital storytelling to facilitate students' inquiry-based learning in the museum*

#### Invitation:

You are being invited to take part in the project *The efficacy of digital storytelling to facilitate students' inquiry-based learning in the museum* which is research towards a doctoral degree at the University of Leicester, United Kingdom. Before you decide on whether to take part, it is important for you to understand why this study is being done and what it involves. Take enough time to read the following information carefully. You are welcome to ask me anything that is not clear to you or if you would like further information related to the project.

#### Purpose of the research study:

This research study will help me understand how digital storytelling supports inquiry-based learning in the museum. Your participation will help me gain more knowledge on the use of digital storytelling as a facilitator to student-initiated and student-run learning enabled by mobile devices. Your data will be used to examine how you benefited from crafting your own digital stories as part of your work on inquiry tasks as a *detective* inside the museum.

#### A few words about me:

My name is Zoi Tsiviltidou and I am a PhD student at the School of Museum Studies in the University of Leicester, United Kingdom. I am carrying out this research study because I want to find out more about digital stories in museum education and understand how students like yourself make sense of the learning experience when you use mobile devices to explore and investigate in the museum what interests you the most, and when you tell your own stories about your experience.

#### How and why you were selected:

You were selected when your school's director accepted my offer and your teacher agreed your class to participate. You and your classmates are an ideal match for the intended target audience for three reasons: first, because your command of the English language suffices you to take part in the study, second, because your curriculum is aligned with the context and purpose of this study, and third, because your age maturity will help you engage both physically and intellectually and gain the most from the learning experience.

#### Research phases:

##### In Phase One

You will attend two classroom-based sessions where you will be introduced to the learning process of the intervention and to the museum's exhibition. You will fill-in a questionnaire about your research skills and work on planning and determining what needs to be known and how for your investigation during the school museum visit.

##### In Phase Two

You will take part in the organised school visit to the ethnographic museum where you will engage in inquiry-based activities to search for information for your digital stories. You will need to **bring your own mobile devices** to engage in material exploration, observe, and take notes and photographs, record sounds as well as your own voices. I will be observing you during the visit (estimated time 2 hours) with the intent of my note-taking will be to observe your behaviour and activities.

##### In Phase Three

You will attend one classroom-based session where you will refine what you have collected during the museum visit, edit and complete your digital stories. You will fill-in a questionnaire about your research skills. Later on, you will take part in a focus group discussion where I will elicit your perspectives of the effectiveness of the task on building your research skills in order to find out whether you benefited and to what extent from the activities.

#### Intellectual property rights and copyright:

By signing the publication agreement form, you agree to keep the copyright to your work, and you give permission to the researcher to use your data for analysis and illustration purposes in writing the thesis and other academic documents. Any digital content that belongs to the museum and you use in your work should be referenced at all times. No other non-educational use will be made without your written permission in a copyright release form.

#### Expected benefits:

The project has links to the Art History course with activities designed in such a way to fit the curriculum. It is hoped that you will have a fun, rewarding and memorable learning experience where you will discover new things about the ethnographic museum.

#### Potential risks:

Health and safety risks associated with the museum visit have been assessed and reviewed by the researcher in a risk assessment document.

#### Confidentiality and protection of personal data:

This research study has been approved by the University of Leicester and complies with the Code of Ethics of the School of Museum Studies, University of Leicester, United Kingdom. All information you provide during the course of the study will be treated according to the Hellenic

Data Protection Authority Guidelines and the relevant UK Guidelines including the Data Protection Act 1998 and will be kept confidential. All data records from this study will be kept secure in a password-protected computer with data encryption. The data you provide will be stored for seven years after the submission of the thesis. Participant names will not be disclosed. Instead, pseudonyms will be used to refer to individual children in order to protect children's anonymity. The research findings will be presented in the thesis and other academic publications including on the Internet. If you have any concerns about the ethics of this research please contact the Ethics Officer, Dr Giasemi Vavoula, by email: [gv18@le.ac.uk](mailto:gv18@le.ac.uk) or telephone: (+44) 1162523866.

Voluntary participation:

Your participation in this study is entirely voluntary. If you decide to take part, you will be given this project information sheet to keep for yourself and you will be asked to sign a voluntary participation consent form. If you do not want to participate in this study, your choice will be respected. You have the right to withdraw your consent with no penalty or loss of benefits any time before, during and within the period of *five months after* the last session of this study. You do not have to give a reason why you chose to withdraw. Remember, being in this study is up to you and no one will be upset if you do not want to participate or even if you change your mind later and you wish to stop. If you are unsure about any aspect of your participation please talk to the researcher to discuss your concerns. I will also ask your guardians/parents to give their written permission for you to take part in this study, but even if your guardians/parents agree, you can still refuse and decide not to participate.

Researcher's contact details:

Zoi Tsiviltidou, PhD student, School of Museum Studies, University of Leicester, 19 University Road, Leicester, LE1 7RH, United Kingdom, email address: [zt30@le.ac.uk](mailto:zt30@le.ac.uk), telephone: (+44)1162523963.

If you have a question later that you did not think of now you can contact me via email.

Thank you for reading this leaflet. I hope you want to take part in the study project.



## APPENDIX XVII

### Student voluntary participation consent form

Trial I student's voluntary participation consent form

I agree that I take part in the study project *The efficacy of digital storytelling to facilitate students' inquiry-based learning in the museum* which is research towards a doctoral degree at the University of Leicester, United Kingdom.

I have had the project explained to me and I have read the Project Information Sheet about the study which I may keep for my records. I understand that this study project will be carried out in accordance with the University of Leicester's Code of Research Ethics which can be viewed at: <http://www2.le.ac.uk/institution/ethics/code>. Material I provide as part of this study will be treated as confidential and securely stored in accordance with the Hellenic Data Protection Authority Guidelines and in compliance with the relevant UK Guidelines including the Data Protection Act 1998.

Questions:	Yes	No
1. I have read, and I understand all the information about the study given to me on the project information sheet.		
2. I understand that my participation is entirely voluntary, and I may withdraw at any time up to five months after the last session of the study without having to give a reason.		
3. I have been able to ask the researcher questions about the study and they were answered to my satisfaction.		
4. I understand that my real name will not be used in any form of writing and my details will be kept confidential.		
5. I agree to take part in the classroom-based sessions and the museum visit and be observed by the researcher, and I understand that data I may provide will be treated as confidential, securely stored for seven years after thesis submission, and will be used by the researcher for writing the thesis and other academic publications.		
6. I agree to take part in the interview with the researcher and my words to be audio-recorded and transcribed, and I understand that anytime I want to stop talking it is fine.		
7. I understand that I keep the copyright to my work, and I will reference any content (including digital) that belongs to the museum, and I grant permission to the researcher to use my work for writing the thesis and other academic publications.		
8. I was given enough time to read the project information sheet carefully and make an informed decision about my participation.		

#### Consent:

Signing my name at the bottom of this form means that I agree that I take part in this study. I will be given a copy of this consent form after I have signed it to keep for myself.

\_\_\_\_\_  
Student

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

## APPENDIX XVIII

### Teacher interview protocol

#### Teacher post-intervention interview protocol

Date:

Interviewer:

Interviewee:

Expected time: 20'

#### Rapport building:

- Greetings, purpose, format and structure of the interview
- Data management and analysis
- Withdraw policy

#### Open-ended discourse:

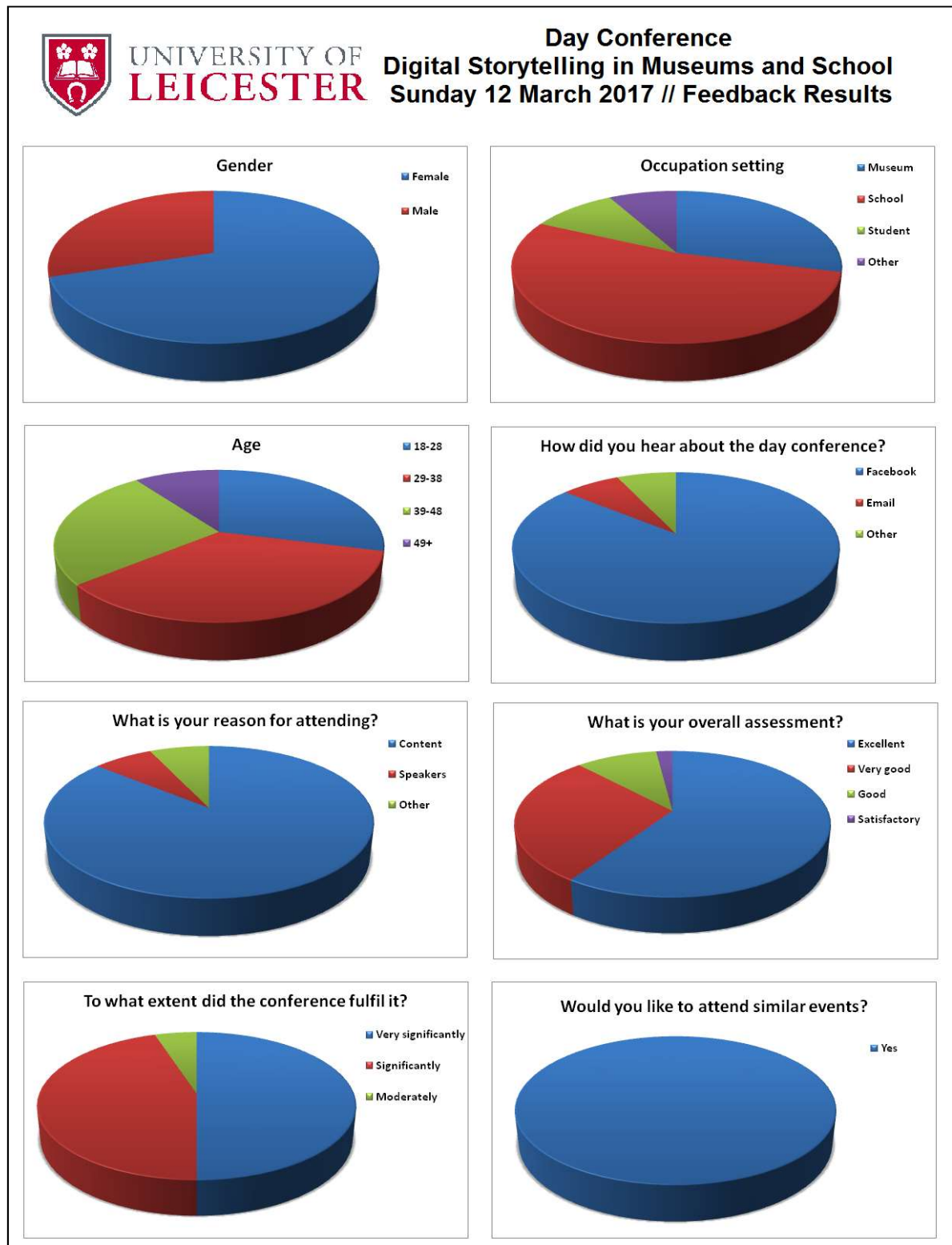
1. How do you integrate the inquiry-based learning process into your teaching? Why?
2. How do you assess their research skills development?
3. Do you think digital storytelling could facilitate inquiry-based learning in the context of the museum? How?
4. What did you expect your students to most benefit from the research?
5. Do you think the intervention sessions were successful? Why yes/no?
6. How was it for the students to conduct the museum investigations framed by digital storytelling?
7. Do you think they benefited?
8. What were the limitations?
9. Do you have any suggestions on how to improve the framework?

#### Wrap-up:

- Do you have any questions you would like to ask me?
- Thank you for your time

## APPENDIX XIX

### The feedback results from the *DSinM&S* Conference



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