Satisfying personal needs at the museum:
The role of digital technologies

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This paper investigates how museum visitors use digital technologies to mediate their general meaning-making process about artworks and other information they encounter throughout their museum experience.

Concluding from a case study at the National Gallery of Denmark in Copenhagen, this study suggests that visitors use digital technologies as a vehicle for satisfying one or more personal needs. In order to gain control over their experience, visitors used not only digital technologies provided by the museum but also their personal technologies.

The article argues that both museums and visitors will derive great benefits by understanding the ways in which people process multimedia messages and by implementing these principles of multimedia learning into the design of digital technologies at museums,. The data also suggest that museums should especially support visitors in using technology with which they are already familiar and embed it in the museum experience.

Introduction

Museums worldwide are enjoying great popularity, and their societal roles are perceived as facilitators of both education and leisure. Symptomatic of this trend, Danish museums

saw a 12.3 % increase in the number of visitors from 2009 to 2010 ("Kulturstyrelsen," 2012). An historically unprecedented number of people now view culture, learning, and self-fulfilment as major leisure goals, which results in museums being one of the most popular free-choice learning settings (Falk & Dierking, 2013, p. 40). In an attempt to keep up with other leisure settings and, at the same time, fulfil their educational role, museums have been trying to cater more to visitors' needs. One of the strategies to attract new audiences is the implementation of digital technologies.

This article constitutes a new approach to the study of mediated meaning-making at museums by integrating empirical and theoretical findings from three different fields of research. This study adds some valuable findings to the use of digital technologies in general at the museum, highlighting how important it is for museums to provide a basic yet very crucial tool for visitors' meaning-making: a free wireless network that facilitates the connection between visitors' personal lives and the museum experience in both directions.

Moreover, this framework creates possibilities for finding some new factors that play a role in relation to visitors' use of digital technologies, drawing attention to the use of visitors' own digital technologies at the museum. Thus far, research has primarily focused on technologies provided by museums. This paper adds to this research by broadening the learning possibilities in free-choice learning settings.

Pierre Lévy notes that "[t]echniques pass, cognitive function remains" (Lévy, 2013, p. 103). This seems to be a simple observation, but the consequences are important: what must come first is the human understanding of the world. In this context, the most appropriate approach is the Cognitive Theory of Multimedia Learning (Mayer, 2005a). It allows us to categorise media based on their content, which is defined by modes of representation. This is useful when trying to understand the cognitive processes and, especially, the efforts that are involved in meaning-making processes at museums.

The Cognitive Theory of Multimedia Learning

"The Cognitive Theory of Multimedia Learning" (CTML) is an approach to understanding how humans process and store information presented through multimedia channels. CTML is interested in the cognitive processes by which people construct meaningful learning outcomes from words and pictures, highlighting that an important part of cognitive psychology is to understand how technology, including multimedia, can be used to foster learning (Mayer, 1999). CTML's focus is not only on which presentation modes support learning but also on which presentation modes have an obstructing influence on learning.

CTML criticizes the implicit theory of learning underlying some multimedia messages, which implies that learning is a single-channel, unlimited-capacity, passive-processing activity. Therefore, the emerging assumptions that undergird the CTML approach concern the workings of the human mind: it is a dual-channel, limited-capacity and active processing system (Mayer, 2005a, p. 37). The theory is, thus, based on the idea that learners actively

seek to make sense of material by selecting pieces of the presented material, organizing the selected material, and integrating it with relevant existing schemas in their long-term memory (Mayer, Heiser, & Lonn, 2001). These knowledge construction processes are executed in working memory (Mayer, 2005a). In detail, these steps are described by the five cognitive processes in multimedia learning, which are as follows:

> 1) selecting relevant words from the presented text or narration, 2) selecting relevant images from the presented illustrations, 3) organizing the selected words into a coherent verbal representation, 4) organizing selected images into a coherent pictorial representation, and 5) finally integrating the pictorial and verbal representations and prior knowledge (Mayer, 2005a, p. 31).

Elsewhere, Mayer defines multimedia learning as the process of "building mental representations from words and pictures" (2005b, p. 15). The term "words" here means, for example, printed text or spoken text, and "pictures" may, for example, be illustrations, photos, animation, or video. In this context, the term "multimedia" refers to the presentation of words and pictures, whereas learning refers to the learner's construction of knowledge (Mayer, 2005b, p. 2).

The museum as a source of education

Over the years, museums' general understanding of their role in society has shifted. In the past, the traditional notion of a museum was as a centre of scholarship and curatorial expertise, as the owner and conservator of cultural heritage (Smithies, 2011, p. 7). The museum has shifted its image towards becoming a more public- and visitor-oriented institution, helping people to learn about society, culture, history and science while also providing entertainment (Smithies, 2011, p. 7).

The shift from conservation to education has also been reflected in recent literature in which the museum is described with more active and reciprocal words, such as "engaging" (Black, 2005), "responsive" (Lang, Woollard, Reeve, & Woollard, 2012), "participatory" (Simon, 2010) and "interactive" (Drotner, Papsø Weber, & Warberg Løssing, 2011). One can also find theoretical reflections such as "constructed" (Hein, 1999), "post" (Hooper-Greenhill, 1999b) and, lastly, "reinvented" (Anderson, 2004).

Meaning-making at museums

Unlike classroom learning, which is composed of linear, sequenced units that rely on prior knowledge and previously-learned concepts, museum-based learning occurs in short time units, does not require continuity, and relies on curiosity, intrinsic motivation, choice, and control (Csikszentmihalyi & Hermanson, 1995; Falk & Dierking, 1992; Rennie & Johnston, 2004).

In order to find a suitable way to describe learning at museums and other out-of-school environments, Falk introduced the concept of "free-choice learning environments", which highlight the learner's agency:

> Free choice learning is a relative, rather than an absolute, construct. The operative issue is *perceived* choice and control by the learner. To qualify as free-choice learning, the learner must perceive that there are reasonable and desirable learning choices (as defined by the learner) available, and that s/he possesses the freedom to select (or not to select) from amongst those choices (Falk, 2005, p. 273).

Some researchers suggest that museums support and facilitate multiple learning outcomes –for example, increase in knowledge and understanding, increase in skills, change in attitudes or values, enjoyment, inspiration, creativity, action, behaviour, progression (GLOs (Generic Learning Outcomes) (Hooper-Greenhill, 2004)), museum literacy, social learning and creativity (Falk, 2004; Hooper-Greenhill, 2004; Leinhardt, Crowley, & Knutson, 2002). These free-choice learning outcomes are, thus, mainly about satisfying intrinsic rather than extrinsic agendas.

Increasingly, the conception of meaning-making by museum visitors is recognized as an essential consideration for museum education (Hooper-Greenhill, 1999a; Rounds, 1999; Silverman, 1995). The visitor does not only go to the museum to learn about what is exhibited but to learn more about themselves and to construct meaning for the world in which she lives (Silverman, 1995). Especially in the context of free-choice settings such as the museum, meaning-making happens actively and is derived from personal experience "through a constant process of remembering and connecting" (Silverman, 1995, p. 162). New information or impressions are matched to a person's past experiences, be they cognitive, affective, behavioural, social, or cultural.

To simplify terms, the definition of meaning-making provided by Lee et al. (2008) will be used in this paper: "The process of connecting new information with prior knowledge, affected by one's intention, motivation, and strategies employed". This sense-making can be directed at the learner and/or objects (Rounds, 1999; Silverman, 1995). The outcomes may be the alteration of long-term memory but may concern working memory as well.

Thus, meaning-making at the museum means the process of making sense of the whole museum experience on all different levels, including the physical, social and personal context (Falk & Dierking, 1992). An individual meaning is constructed in relation to anything that is encountered and matched with prior personal experiences. This happens both consciously and subconsciously.

The museum experience

The museum visitor experience is an intangible, ephemeral and constructed relationship that occurs uniquely each time a person visits a museum (Falk & Dierking, 2013). The main

framework, which is used here to investigate technology experiences in museums, was proposed by Falk and Dierking (1992). This visitor-centred approach provides useful methodological tools to investigate visitors' agendas and methods for satisfying their identity-related needs. They claim that:

> Whether alone or in a group, the typical museum visit represents a strategy on the part of the person or group to use the physical context of the museum as a vehicle for satisfying one or more personal and/or sociocultural needs (Falk & Dierking, 2013, p. 31).

Museum visitors are equipped with identity-related needs and desires that stem from their everyday lives and experiences. They come to the museum with certain expectations that are ascribed to the museum and matched with their own needs. Falk and Dierking have used this identity lens to describe predictive museum visitor categories (Falk, 2009).

Keeping in mind that a regular museum displays a wide variety of exhibits, it is highly unlikely that a visitor has the temporal and cognitive capabilities to pay attention to everything he or she encounters (Falk & Dierking, 2013). Thus, selectivity is an important component in the learner's behaviour at museums.

Digital technologies in museums – review

Research on digital technologies is still in its infancy – just like the technologies themselves: they were introduced to museums in the 1990s (Drotner & Laursen, 2011, p. 2). Consequently, Falk and Dierking address the paucity of research on this topic:

> More research and evaluation needs to be conducted in this arena, particularly empirical studies that compare the use of such technologies to visits without their use or to the use of more traditional media. It is not until the field has a strong research base that it will truly be able to optimize the power of these digital media tools (2013, p. 123).

Some of the literature in this emerging research area has theoretically and, to a certain extent, also empirically focused on determining the potential and challenges of digital technologies (e.g., Drotner et al., 2011; Tallon & Walker, 2008; Wessel & Mayr, 2007). The efficacy of the technologies in learning support has been tested in some studies (Arvanitis, 2005; Kahr-Højland, 2010; Knipfer, Mayr, Zahn, Schwan, & Hesse, 2009); however, this research was predominantly conducted in a science museum setting and/or covers only the mobile aspect of digital technologies. Therefore, it cannot be applied to the entirety of technologies used at museums. Falk et al. (2004) suggest that visitors expect different learning outcomes from science museums compared to art museums.

Thus far, the literature on museum media does not provide a clear definition of the term. This lack of a clear concept is assumed to be due to the ongoing rapid technological developments that result in change and even in some technologies becoming obsolete (cf. Falk & Dierking, 2013, p. 122). The term "digital technologies" is often used in a very broad

and self-explanatory sense. However, when we focus on what the authors mean by this description, many discrepancies between the meanings arise. For instance, digital is used as synonym for only one part of the phenomenon – with words such as "virtual" (Skov & Ingwersen, 2008), "interactive" (Drotner et al., 2011) or "mobile" (Tallon & Walker, 2008). Most recent literature has focused on mobile technologies (Arvanitis, 2005; Kahr-Højland, 2010; Naismith & Smith, 2009; Tallon & Walker, 2008; Wessel & Mayr, 2007).

Thus far, some researchers have dismissed the idea of museum visitors using their own devices due to practical constraints, pointing out the costs of Internet access (or roaming) and the lack of appropriate personal technologies (Walker, 2010, p. 41). However, these constraints might be out of date; statistics on the distribution and adaptation of smartphones prove that a steadily growing number of people own them. Countries such as the US and Denmark now have more than 40 % smartphone penetration ("Our Mobile Planet," 2013). Gammon and Burch (2008) support the idea of visitors using their own devices due to the simple fact that visitors are already familiar with their design.

In this study, the term digital technology is used in a broad context because, first of all, there is no other suitable definition on which to rely. Thus, I am using an exploratory openness of the term, which allows the incorporation of a wide variety of technologically-mediated ways for the visitor to make sense of the museum experience. The technologies discussed in this paper also include Wi-Fi because it provides access to the individual seeking information.

In sum, the digital technologies analysed in this paper are defined by the following criteria:

1) Providing access to additional information to enhance the museum experience, especially when it is characterised by a mix of presentation modes such as text, audio and video.
2) Providing access to (additional) interpretive material.
3) Being interactive and responsive to the user (to varying degrees).

Research design and study

The paper raises the following research question: *What roles do digital technologies play in the visitor's meaning-making process at art museums?*

In order to answer the main question, a subset of research questions guided the study, while following the general research design of Falk et al. (2004):

Question 1: What do visitors bring to their museum experience generally in terms of prior knowledge, interest, agenda and perceptions?

Question 2: What types of affordances and characteristics can be ascribed to the technologies at the museum?

Question 3: What factors can be related to visitor choices and their use of technologies?

Question 4: What patterns of technology use can be detected?

Question 5: In what ways does the use of digital technologies influence visitors' exit attitudes?

Due to the scarcity of empirical research investigating the use of digital media at art museums (Tallon, 2008), an urgent need for an exploratory case study design was detected. This means that the study at hand must be seen as preliminary because the phenomenon of technologically-mediated meaning-making at the museum has not hitherto – to my knowledge – been thoroughly investigated. Consequently, the data for this study were collected using three overlapping data collection methods in order to ensure validity.

The National Gallery of Denmark [*Statens Museum for Kunst* (SMK)] in Copenhagen served as the naturalistic setting for this case study. Thanks to its fixed organisational and architectural structures, a museum as such is particularly suitable as a naturalistic but controlled research setting. SMK is Denmark's largest national art gallery. Now, in the year of 2013, the gallery finds itself at the end of a five-year process called the "SMK Digital" strategy. It consists of a series of projects that contribute to the construction of an overarching digital arts mediation by implementing new technologies at the museum.

On the temporal level, the study analysed a complete visit from entry on site to exiting the exhibitions. The research was conducted over three days during a period of one week in April 2013. Random museum visitors were approached before entering the exhibitions by the researcher. A total of eight adult visitors participated. The respondent's ages ranged from 22 to 35 years.

The approach I have chosen for this study is interaction-centred, which means that I examined both the visitor and the setting variables as well as how the two might interact (Bitgood, Dukes & Abbey, 2006). Therefore, not only the visitors and their experiences were analysed but also the digital technologies and their characteristics.

Parallel lines of analysis were developed for the process of data collection. As a first step, a rich literature trawl was conducted. The study builds on a number of other studies that have sought to explore the subject of digital technologies at museums (Holdgaard & Simonsen, 2011; Kahr-Højland, 2010; Laursen & Houlberg Rung, 2012; Schwan et al., 2008). However, mainly due to the quick and steady evolution of those technologies and the unclear definition of what digital technologies entail, the researcher was open to additions and changes throughout the course of the data collection in order to make sure no new developments were missed.

So far, a number of useful frameworks exist for the field of museum visitor studies (e.g., Falk & Dierking, 1992; Hooper-Greenhill, 2001; Hein, 1999; Leinhardt et al., 2002; Paris, 2002). Each focuses on a specific context and, therefore, does not cover a full overview of all the factors, interactions and processes involved in museum experiences. Falk and Dierking's approach, however, can be seen as one of the most thorough frameworks developed so far and is steadily kept up to date.[1] Additionally, focusing on the meaning-making pro-

cess, Hooper-Greenhill's study design (2001) was adapted to the overall case study and was, thus, used as a complement to Falk and Dierking's design when it could add something useful to the framework.

Hence, the basic research design for this study included Personal Meaning Mapping before and after the museum visit (including short interviews afterwards) and an unobtrusive observation of visitors during the visit. For baseline data, a questionnaire was to be filled out by the visitors before and after the visit.

The technologies analysed at SMK were as follows: Two digital desks in the permanent collections, several mobile and fixed iPads, one computer terminal with access to the online portal, another computer terminal with general access to the Internet, a digital poll about an exhibition and an open Wi-Fi network.

Findings and discussion of questions

Question 1: What do visitors bring to their museum experience generally in terms of prior knowledge, interest, agenda and perceptions?

Overall, the respondents from this study show a high interest in museums in general and the exhibited artworks. Findings from the PMMs show that they have a general idea of what an art museum entails. Moreover, the respondents have gathered various experiences from past visits, which are also connected to emotional memories. The prior experience also includes interactions with digital technologies, which have been predominantly positive. Even though the sample was random, the analysed respondents are rather homogeneous. They generally visit museums between once a year and monthly, which is consistent with Danish museum statistics.[2] 56 % of Danish art museum visitors stated that they visit four times or more per year (Lundgaard, 2012).

In summary, the findings from this study show that visitors brought four main kinds of prior personal experience and related cognitive schemas with them to the museum. They include art in general, the museum in general and specific memories from prior visit experiences, technologies in general and, lastly, information gathered as preparation for particular museum visits.

The respondents each named several reasons for their visit in the questionnaires. However, Falk and Dierking (2013) note that self-reported reasons for visiting a museum might not cover all the motivations that influence a visitor's museum experience. It is assumed that respondents might not mention reasons that seem too obvious (ibid., p. 45). Therefore, the observed actual behaviour and information derived from the PMMs were combined with the reasons given by the respondents in order to determine the following four visitor types in this study. The visitor types can sometimes occur in combination, as is the case in this study. Thus, the participants were attributed characteristics from more than one visitor type.

1) Explorers: they are curiosity-driven and interested in the content, waiting for something to grab their attention. The visit to the museum fuels their curiosity and learning;

2) Experience Seekers: they consider the museum itself as an important destination and visit simply because it is there;

3) Rechargers: they are contemplative, spiritual and seek a restorative experience. The museum serves as a refuge; and, lastly,

4) Facilitators: they are socially-motivated and focus on enabling the experience of others in their accompanying social group (Falk, 2009).

All respondents expected the museum to provide or stimulate creativity, inspiration and interpretation. The museum was also generally perceived as a place for learning. Their own definitions of learning were very broad and not restricted to the mere acquisition of facts. Learning at the museum is understood as being able to make connections and gain perspective by relating background (i.e., historical) information to the exhibits or exhibitions in order to make sense of one's own experience. Learning outcomes were described in relation to the learner, society and the topic. These findings, therefore, reinforce the currently accepted notions that visitors enter the museum equipped with pre-existing knowledge, experience, interests and motivations (cf. Falk, Scott, & Dierking, 2004; Falk & Storksdieck, 2010; Hooper-Greenhill, 2001).

Question 2: What patterns of use can be detected?

The findings partly support Falk and Dierking's assumption that the distribution of technology use is "bimodal" (Falk & Dierking, 2013, p. 120), which means that some visitors used very little or no technology at all, while others engage more actively in technology use. The visitors observed who did use technology behaved very selectively and made use only of a small number of the media provided by the museum. The findings from the questionnaires show that the distribution of technology use is unique each time a person visits the museum. Bimodal could, therefore, also describe an individual visitor's usage pattern throughout a series of individual museum visits. This finding is open to more research – to detect general patterns in a larger-scale quantitative study and also to take the differences between science and art museums into consideration.

Moreover, visitor technology use was also found to be highly selective. Prior research assumes that curiosity-driven visitors (i.e., Explorers) tend to be especially selective in their use of exhibit elements, which results in greater achievement of their own goals (Rounds, 2004). For example, visitors check out the overall nature of the technology and its content before actually deciding to use it. Hence, visitors display strategies of weighing the benefits against the costs. This finding supports the "general value principle", which describes these benefits-versus-costs strategies that determine how visitors focus their attention and what they will subsequently experience (Bitgood, 2006). The study showed that some visitors

completely ignore (some) technologies provided by the museum. Further research will be needed to determine the reasons for this complete disregard.

Moreover, this study detected temporal visitor patterns: it was observed that the use of technology is distributed throughout the whole visit. The individual time spent using a technology can range from only a few seconds up to several minutes, depending on content, medium and intensity of engagement. No visitor has been observed using one medium constantly. As suggested by Schwan et al. (2008), use depends on short learning episodes, which can be sparked by several factors, such as the generation of interest and knowledge related to parts of the exhibition that arises from visitors' individual or collaborative learning processes when interacting with the exhibits (2008, p. 122). In addition, some visitors in this study used technologies up until the last minutes of their visit. This finding contradicts assumptions that visitors were more likely to use media early in a visit and become increasingly more selective as they reach cognitive or sensory overload (Walker, 2010, p. 37). Since the studies that led to this assumption were conducted 15 years ago, I assume that the technologies offered by museums were sparse and different (such as computer terminals) and that this might have led to different findings. I would, therefore, suggest further quantitative investigation to help solve the disparity between these findings.

In general, this study found that visitors used a variety of information materials throughout their visit. Depending on the affordance of the material, either a simultaneous or alternate usage pattern occurred. These findings are also consistent with prior research (Walker, 2010, p. 279).

Question 3: What types of affordances and characteristics can be ascribed to the technologies at the museum?

Answers from the questionnaire about the respondents' prior interest and knowledge led to the conclusion that the virtual material, such as the museum's website, was mostly used by visitors to prepare for their visit.

Supporting the claim that visitors to museums need control over their visit (Falk & Storksdieck, 2005) is the finding that they also use their own technologies at the museum. They use their own smartphones to access the World Wide Web and look up information regarding the artwork they are looking at on the spot in that exact moment. One respondent replied "Wi-Fi" to the question "which technology did you find most useful?" This leads to the assumption that the respondent is aware of a free network as part of the choice of technologies a museum can provide. The behaviour seems effortless and occurs in a matter of seconds. The ease and speed of smartphone use lead to the assumption that visitors might prefer their personal technologies because they are already familiar with their device and already know how to operate it (Gammon & Burch, 2008).

Visitors were observed using their smartphones to take photos both of the artwork and the information on the labels. Respondents who took pictures with their smartphones stated that they wanted to be able to 'revisit' the experience in the future or to share the

discovery with someone else who was not present (e.g., on a blog or via email). In the latter case, one visitor even sent the picture instantly via the Internet to another person outside the museum. The visitor is assumed to have been conscious of the museum's physical and temporal limitations and, thus, found a solution by saving important information that would help them (re-)connect with their experience in the future. This extrinsic memory may also be interpreted as some kind of cognitive offloading because visitors then do not have to memorise the details of an artwork.

Furthermore, one of the visitors used the smartphone to interact with the artwork by taking a picture of herself mirrored in one of the objects. By taking a picture of herself mirrored in the artwork, she became part of the artwork itself. Thus, she constructed a subjective meaning of the object.

Some respondents also replied that the technologies added to the experience, enhancing visitors' objective meaning-making. On the other hand, information provided by some technologies might appear extraneous to the visitor. Depending on the context – e.g., a socially-motivated visit, a technology may also be perceived as distracting because it interferes with the current visit situation.

From the findings, we can see that most visitors have a general idea of what digital technologies at the museum imply and what they can get out of them. In general, five distinct affordances of technologies emerged as most important to these visitors:

1) Providing additional (interpretive) information (objective meaning)
2) Topic-relatedness and 'just-in-time'-ness
3) Control and agency
4) Creation of personal connections with part of the experience (subjective meaning)
5) Ease and familiarity

Question 4: What factors can be related to visitor choices and their use of technologies?

The three contexts identified by Falk and Dierking provide a good framework for approaching this question. I will use them to show up the complex interplay between the factors.

Personal context: The present findings seem to be more consistent with other research, which found that visitor agendas and identities (Falk & Dierking, 2008, 2013) and related information needs (Rounds, 2004) on the day of the visit influenced the use of technologies. The visitor types that did not use technologies or dismissed them after having checked them out were categorised as Facilitators or Rechargers; whereas Explorers and Experience Seekers mainly uses various technologies on the visit analysed.

As mentioned in the literature review, several studies from science museums support the idea that the use or non-use of digital technologies is influenced by prior knowledge and topic-related interest (Corredor, 2006; Schwan et al., 2008). Although I believe these assumptions to be correct, the findings from this study do not completely support the

correlation between the three factors prior knowledge, interest and technology use. The respondents who did not use technology rated their prior knowledge on the exhibition content as low to moderate; however, so did some of the respondents who did use technology. Moreover, those respondents who did not use any digital technologies at all rated their interest in the topics as moderate to high. I assume that self-reported knowledge and interest are very relative and that this could be a reason for the missing connections. However, data from the PMMs supported the idea that the respondents had been interested in and knowledgeable about art museums in general prior to their visit.

These preliminary findings suggest that personal factors – especially, prior experience – might not be the most dominant influence on the choice of technologies. When we look at what visitor types did not use technology – namely, Facilitators and Rechargers, we can see that the social nature of the visit seems to be of higher importance than personal characteristics. Given the fact that the majority of museum experiences are of a social nature[3], the social context and influence on technology use must be highlighted.

Sociocultural context: From a socially-motivated point of view, digital technologies might be seen as disruptive. When we, for example, look at the 'Facilitator' visitor type with his or her goals to provide and experience a group-centred visit, using technologies individually might not be part of that agenda. One visitor group indicated in the questionnaires that they were visiting with friends and, throughout the visit, they exchanged thoughts and interpreted artworks together. When this group explored the iPads, they quickly dismissed them because they thought it was "anti-social" and "too much to read right now". On the other hand, two visitors who had arrived at the museum together did use technology throughout the visit. The difference between the two groups was that the latter two visitors did not interact with each other and focused on the exhibition. Thus, it might be the expectation of a social experience that is important, i.e., the intrinsic agenda, and not the actual group formation. The dominant nature of intrinsic goals found in this study is consistent with Falk and Dierking's ideas on visitor agendas.

Physical context: In this context, factors such as accessibility, availability, and information are relevant. For instance, none of the visitors in the study knew that there were mobile iPads available from the information desk. One respondent stated that she would have used an iPad if it had not been fixed to the seating area. Another respondent replied that he did not use any technologies, because they were not available in English – which is not the case since SMK has a strict policy of providing all information in Danish and English. These findings support Falk and Dierking's assumption that media use is influenced by the physical context, such as the availability of seating or the placement of the medium (2013, p. 120).

Moreover, the content of the technologies is obviously an important factor. When it relates to visitor interest and is topic-related, it is more likely that the technologies will be used. However, the fact that some content appears too extraneous might result in visitors

not using the technology. Another possibility is the presentation mode of the informa-
tion. A long text might not be desirable to engage with, as the dismissal of the iPad in the
case study showed. Hence, technologies might be ignored for the following reasons: lack of
information about availability and accessibility, placement, the visitor's own lack of knowl-
edge about the affordances of the technologies.

In contrast, the use of personal technologies seemed effortless and provided visitors
with the desired information. Visitors already had their smartphones in their pockets and
were, therefore, able to choose the place and time of the interaction. No further efforts on
the visitor's side such as accessibility or availability were perceived as problematic in this
context.

Lastly, other information/interpretive material might be sufficient for some visitors, as
some respondents have stated in the questionnaires. When they are easily accessible, such
as wall texts, visitors' information needs might already be satisfied.

Question 5: In what ways does the use of digital technology influence visitors' exit attitudes?

Tracing back visitors' exit attitudes to the use of technologies was not entirely possible,
due to the time restrictions of the study. However, some respondents added words such as
'interactive' to their PMMs after the visit, which is assumed to be an outcome of their inter-
actions with the technologies used. Three subjects mentioned technologies in their PMMs
or verbally while explaining their meaning map. For instance, one respondent added "iPad"
to her meaning map after the visit because it had been part of her prior experience at the
visit analysed. While elaborating, she explained that, to her, the museum experience means
"not being distracted by modern things like computers". However, this statement is more
likely traceable to related questions in the questionnaire that was filled out just before the
PMM. Follow-up interviews would be necessary to investigate this question further.

Synthesis of findings

Visitors' self-reported attitudes and observed behaviours confirmed the working definition
of "meaning-making", which I have developed for the purpose of this study. I have defined
"meaning-making" at the museum as "the process of making sense of the whole museum
experience on all different levels, including the physical, social and personal context. An
individual meaning is constructed in relation to anything that is encountered and that has
to be matched with prior personal experiences. This happens both consciously and sub-
consciously".

For the purpose of satisfying their learning-related goals and constructing meaning
from their museum experience, the participants of this study were found to deploy dif-
ferent strategies – one of which was the use of digital technologies. However, this study
also showed instances in which visitors dismissed a digital technology as disruptive to the

experience or considered the content "extraneous". Others expressed preferences for other media, such as an audio guide.

The digital technologies analysed in this study all included at least one of the multimedia presentation formats – but the majority of technologies were indicated as multimedia-rich, containing a combination of pictures, text, and audio. This leads me to assume that some digital technologies bear a potential for cognitive constraints solely caused by the way they are designed. When a visitor thus weighs the benefits against the costs of using a technology, this perceived potential cognitive cost (for instance, "extraneous" information) is assumed to lead to the decision not to use the medium.

Cognitive implications for museums

At this point, when the most important findings from this study have been presented and analysed, I will use the Cognitive Theory of Multimedia Learning to provide explanations for some of these facts related to digital technologies. Moreover, I will apply CTML to show how museums could support visitors more in their meaning-making process by applying these insights to the design of the technologies and their physical placement within the museum.

From what we understand about the museum experience, a visitor is involved in various meaning-making processes involving a plethora of factors such as basic needs of leisure and organization, which already begin before the visitor even enters the museum (cf. Falk & Dierking, 1992). The processes can be described as 'incidental processing' because it is aimed at nonessential aspects (Mayer et al., 2001, p. 45). However, some visitor types – such as Explorers and Professionals – come to the museum with the specific expectation to learn something from the exhibitions. Therefore, the 'essential processing' in the context of museum learning describes primarily the process aimed at making sense of the exhibits including selecting, organising, and integrating words and selecting, organising, and integrating images. Most artefacts at art museums are arguably in the presentation format of images rather than texts, but they are clearly not restricted to this form of representation. When the visitor wants to interpret the artwork and employ the strategy of consulting content-related information, she will be involved in the process of 'representational holding', aimed at holding verbal or visual representations in working memory to match it with the other pieces of information. This is the point at which cognitive overload can easily occur.

Meaning-making describes the process of constructing meaning by matching anything that is encountered with prior personal experiences. Thus, when a visitor simultaneously has to process different information through different (dual) channels and try to match that organised information with prior knowledge and, at the same time, encounters fresh information, new mental schemas have to be created. This simultaneous processing creates high cognitive load. Hence, especially when the visitor is presented with new information, which is a desired affordance from a museum visit, she will have better chances to succeed

in making meaning from that material when her working memory is not heavily loaded simply from trying to process and organise multimedia contents.

Thus, museums should take Sweller's advice into consideration when designing additional interpretive and orientation material:

> Instructors need to keep in mind that before learners faced with novel material can organise and incorporate it in long-term memory, they must process it using a limited working memory that includes partially independent channels for auditory and visual information (2005a, p. 26).

So if the affordances of digital technologies are to be perceived as helpful, interesting and adding to the experience, the technologies should take the visitors' needs and cognitive capabilities more into consideration. Cognitive overload is surely not one of a visitor's needs – especially, for people with little prior knowledge and, perhaps, little interest.

However, cognitive load can be reduced by being aware of the Mayer's principles (2005b) listed below. If these principles were understood by technology designers and exhibition designers, extraneous cognitive load might be reduced.

1) *Multimedia principle:* Information processing is facilitated when words are presented in the auditory channel, and additional content-related information is presented in the visual channel (Mayer, 2005b, p. 6). Therefore, it seems advisable to present content which is directly related to artworks through means such as audio files or guides, which only contain little or no text at all.

2) *Spatial and temporal contiguity principle:* People learn better when corresponding words and pictures are presented near rather than far from each other on the screen or in time (Mayer, 2005b, p. 6). The principle supports the potential of mobile technologies as primary interpretation material for objects and artworks, since mobility facilitates information retrieval 'just in time' and is independent from spatial limitations.

3) *Redundancy principle:* The redundancy effect occurs when additional information results in learning decrements compared to the presentation of less information (Sweller, 2005b, p. 159). This happens, for example, when the same information is presented in different forms or with unnecessary additional explanatory material. Redundancy leads to an increased extraneous cognitive load, which consequently disrupts the learning process (ibid., p. 167).

 This leads to the recommendation that primary interpretative material should not contain unnecessary information.

4) *Split-attention principle*: Split attention occurs when two or more sources of information must be processed simultaneously in order to derive meaning from the material. The learner must split her attention between the sources (which might be temporally and physically separated) and mentally integrate them, resulting in

an increase in cognitive load (cf. Sweller, 2005a). This principle could, for example, be applied to background information – whether in a written or oral text – that includes more in-depth information about some artwork. The digital text should always include a representation of that artwork in the multimedia material. In that way, the visitor does not have to jump back and forth physically or temporally to compare the original with the description.

Conclusion

This study produced results that corroborate the findings of a great deal of the previous work in this field. Moreover, this framework opened possibilities for finding some new factors that play a role – especially, in relation to visitors' use of their personal technologies.

The findings from this case study support and highlight the notion of agency. Visitors were found to possess a medium to high literacy regarding museum and information. They knew what to expect from a museum experience in general, and their knowledge was based on previous experiences. They were, furthermore, able to report why they had used specific technologies throughout the visit; some even used strategies of weighing benefits versus costs.

Visitors made use of digital technologies that were appropriate to their personal needs and agendas. Whether these behaviours are conscious or subconscious is not clear because the observation's unobtrusiveness did not allow any interposed questions about motives. However, I assume that each visitor ascribed preconceived affordances to the digital technologies, meaning they had certain expectations to what a certain medium would enable them to experience. Thus, these affordances were considered to be a means to an end for their personal agendas. As Falk notes, visitors' agendas are both subconscious and evident (Falk, 2009). Therefore, I assume that technology affordances follow the same principle.

The ascription of affordances leads to the second important notion of control. A basic characteristic of free-choice learning, control describes the freedom to select (or not select) from among the choices a setting provides (Falk & Storksdieck, 2005). In this case study, visitors appeared to be in control of their technology use and general museum experience. The assumption of control is derived from the findings that visitors deployed strategies of selection and that they were later able to report on their usage behaviour and give reasons for their selection of technologies. In this context, I assume that the visitors who used their personal smartphones gained control by using a technology that was familiar to them. The affordances of their own devices were already established. Therefore, they knew what to do in order to get the desired outcomes (i.e., information, interpretation, interaction, memory).

The important observation one must keep in mind is that, depending on the choice of technology the museum offers, visitors make sense from more than just one medium throughout the museum experience. As suggested by Alsford (1991), one can, thus, define

the whole set of technologies in museums as "hypermedia", stressing the importance of information as opposed to objects as their main resource.

> The term hypermedia is commonly used to refer to this type of information resources [sic] and is based on the term hypertext, coined by Ted Nelson around 1965 to refer to "nonsequential" or "nonlinear" text where authors and readers were free to explore and to link information in ways that made personal sense for them (Dillon & Jobst, 2005, p. 569).

The results of the study show that the framework provided by the Contextual Model of Learning (Falk & Dierking, 1992) was an appropriate way to understand how the complex combinations of factors influenced visitor learning – yet, with limitations on the subject of meaning-making from art. Hooper-Greenhill's work offers qualitative approaches to add to this framework. Moreover, the collected data have shown that, in order to capture the factors that influence the use of digital technologies and their role in the meaning-making process, cognitive theories must be taken into consideration. Neither the Contextual Model of Learning nor Hooper-Greenhill's framework are adequate in this respect. The Cognitive Theory of Multimedia Learning helped to give an explanation of the demands that influence the efficacy and use of the technologies.

Even though Falk and Dierking consider their model 'contextual', its visitor-centred perspective fails to provide important explanations for the use of digital technologies. For this reason, an interaction approach, which combines both visitor and setting variables (including digital technologies) and examines how the two might interact, was found to be more appropriate.

> [...] though widely hailed as the solution of the future, at the moment these technologies are still in their infancy. It would not be surprising to us if soon after this volume goes to print, most of what is currently hailed as cutting edge and effective practice in handheld technology becomes obsolete, so rapidly is technology changing (Falk & Dierking, 2013, p. 122).

Implications

The implications that can be derived from this body of work concern the use and design of digital technologies by museums.

As part of their educational role, it seems logical that museums offer a variety of information material, part of which is digital technology. As this study shows and other research has also proven, digital technologies support the reinvented museum with their interactive and responsive nature. This paper demonstrated how the presentation form of the content matters and that it might serve as a criterion to decide whether visitors will even use a technology or not. It is highly recommended that museums understand their visitors' needs but also their constraints before implementing or experimenting with new technologies.

These findings might even be good news for smaller museums that do not have the resources to implement specially designed technologies for their audience. As a first step towards meeting visitors' needs, it might be sufficient to offer free access to the Internet. This study supports the notion of a new culture of learning, which is characterised by demand-driven rather than supply-driven, highly structured forms of learning (Thomas & Brown, 2011).

In conclusion, the role of digital technologies at museums is to act as a vehicle in a strategy to satisfy one or more personal needs on the part of the visitor. Those needs are, for example, information retrieval, orientation, interpretation, interaction, and memory.

The actual use of digital technologies is dependent on several factors, such as physical context, personal needs, and the weighing of benefits and costs – which can be both personal and sociocultural.

Digital technologies have the potential to connect the visitor's personal life with the museum experience – especially, the use of visitors' personal technologies, facilitated by the museum's Wi-Fi network, enables a two-way relationship in which the visitor can both research discrete points of interest and subscribe to in-house resources. To be more specific, technologically-mediated meaning-making works in both directions: the person can mediate a personal meaning *onto* the museum experience but can, at the same time, receive a mediated meaning *from* the museum experience through the digital technology.

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Notes

1   In the beginning of 2013, Falk and Dierking published a revised edition of their book *The Museum Experience*, which originally came out in 1992.

2   "56 % af kunstmuseernes brugere har fire eller flere museumsbesøg per år mod 37 % af brugerne på de kulturhistoriske museer og 38 % af brugerne på de naturhistoriske museer".

3   According to Danish Museum statistics, only 7 % of visitors go to the museum on their own, whereas "46 % af brugerne på de danske museer kommer i grupper bestående af 3-6 personer, mens 34 % af brugerne kommer i grupper med to personer" (Lundgaard, 2012, p. 57).

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