



DEPARTMENT OF EDUCATION,
COMMUNICATION & LEARNING

MOVING BETWEEN LEVELS OF ENGAGEMENT WITH INTERACTIVE DIGITAL EXHIBITS

Case-study: Human Nature Exhibition at the
Museum of World Culture

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Supervisor:	Alexandra Weilenmann
Examiner:	Thomas Hillman
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Abstract

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Purpose: The overall purpose of the study is to explore how engagement with digital interactive exhibits can be evaluated in a museum rather than in a science centre setting and scrutinize factors that encourage or hinder visitors' engagement. This is examined using a case study of the Human Nature exhibition displayed at the Museum of World Culture (Gothenburg, Sweden).

Theory: The study is built upon the Contextual Model of Learning grounded in the ideas of constructivism. It provides a suitable framework to explore the multidimensional nature of interaction with exhibits from the perspective of an active visitor who constructs one's own meaning based on personal, social and environmental factors.

Method: The chosen design frame is the case study that enables obtaining a detailed and rich understanding of the visitor's experience. The combination of methods, i.e. accompanied visits and observations followed by short interviews with visitors, provides an insight into how engagement unfolds in a unique context of a particular exhibition.

Results: The main contribution of the study is the adapted Visitor Engagement Framework that may serve as a method to evaluate engagement with digital interactive exhibits in the context of museums. The study also outlines the characteristics of personal, physical, and sociocultural contexts that may influence visitors' engagement with exhibits.

Foreword

I would like to wholeheartedly thank my supervisor Alexandra Weilenmann at the University of Gothenburg for her support, guidance, and feedback. I would also like to express my gratitude to the Museum of World Culture (Gothenburg, Sweden) for making this research possible, sharing valuable advice, and supporting me throughout the process. Thank you to all of the participants who generously devoted their time, shared their unique perspectives and experiences. They are undoubtedly at the very core of this research. And last but not least, I would like to thank the Swedish Institute and the Visby scholarship program, that made this study possible in the first place.

Table of content

List of Figures.....	7
List of Tables	8
1. Introduction.....	9
2. Literature review.....	11
2.1. Reviewing definitions of engagement.....	12
2.2. Measuring engagement.....	13
2.2.1. Timing and tracking.....	13
2.2.2. Visitor Engagement Framework	13
2.3. Factors influencing engagement.....	15
2.3.1. Exhibit characteristics influencing engagement	16
2.3.1.1. Interactivity	16
2.3.1.2. Participation.....	16
2.3.1.3. Ease-of-use.....	16
2.3.1.4. Conceptual coherence.....	17
2.3.1.6. Affordances for social interaction	17
2.3.1.7. Providing new information.....	17
2.3.1.8. Technological novelty	17
2.3.1.9. Narrative.....	18
2.3.2. Personal characteristics influencing engagement	18
2.3.2.1. Preferences and interests	18
2.3.2.2. Previous knowledge	18
2.3.2.3. Expectations	19
2.3.2.4. Control, agency, and decision-making.....	19
2.3.3. Sociocultural context influencing engagement.....	19
2.4. Concluding remarks and definitions of key concepts.....	20
2.4.1. Engagement of a visitor with an interactive digital exhibit	20
2.4.2. Interactive digital exhibit	21
3. Theoretical background	22
3.1. Constructivism.....	22
3.2. Contextual Model of Learning	22
4. Methodology.....	25
4.1. Setting.....	25
4.1.1. Exhibition.....	25
4.1.2. Digital interactive exhibits.....	25
4.1.2.1. Re:Heritage exhibit.....	25
4.1.2.2. ‘What Do You Think about Sustainable Consumption?’ exhibit.....	26

4.1.2.3.	Cups exhibit.....	27
4.1.2.4.	Change exhibit.....	27
4.1.2.5.	Smart Map exhibit.....	28
4.1.2.6.	Robot exhibit.....	29
4.1.2.7.	Dark Room exhibit in the Emotional Landscapes area.....	29
4.1.2.8.	‘Leave Your Own Examples of Sustainability’ exhibit.....	30
4.1.2.9.	Climate Vision exhibit.....	31
4.2.	Participants and data gathering tools.....	31
4.2.1.	Stage 1: Accompanied visits.....	31
4.2.1.1.	Participants.....	32
4.2.1.2.	Procedure.....	32
4.2.2.	Stage 2: Observations and short interviews.....	33
4.2.2.1.	Participants.....	33
4.2.2.2.	Procedure.....	34
4.3.	Analytic procedure.....	35
4.4.	Ethics.....	35
5.	Findings.....	36
5.1.	Evaluating engagement using the Visitor Engagement Framework and holding time analysis.....	36
5.1.1.	High cognitive engagement combined with negative evaluation of an exhibit.....	36
5.1.2.	Emotional engagement as the main outcome of the interaction.....	37
5.1.3.	Repeating the activity does not always translate into higher engagement.....	38
5.1.4.	The resulting adapted Visitor Engagement Framework.....	38
5.1.5.	Visitor Engagement Profile (VEP).....	39
5.1.6.	Comparing the analysis of holding times and the Visitor Engagement Framework.....	40
5.2.	Personal, sociocultural or physical factors influencing visitors’ engagement level.....	42
5.2.1.	Physical context.....	42
5.2.1.1.	Visual attractiveness, length, and ease-of-use – important but not enough for high engagement.....	42
5.2.1.2.	Lack of control leading to frustration.....	43
5.2.1.3.	Unclear messages and lack of conceptual coherence as constraints of engagement.....	43
5.2.1.4.	Passive nature of an exhibit as a reason to disengage.....	44
5.2.2.	Personal context.....	44
5.2.2.1.	Previous knowledge determining the level of engagement.....	44
5.2.2.2.	Appealing to personal background and interests as a way to engage visitors.....	45
5.2.2.3.	Disengagement as strategic decision-making.....	45
5.2.3.	Sociocultural context.....	46
5.2.3.1.	Influence of companions on the experience of interaction with exhibits.....	46

5.2.3.2.	Privacy as an aspect of social context influencing engagement.....	46
5.2.3.3.	Participatory exhibits: what is the value of participation?	47
6.	Discussion.....	49
6.1.	Adapting the Visitor Engagement Framework for the Human Nature exhibition	49
6.1.1.	Elaborating emotional engagement.....	49
6.1.2.	Excluding repetition.....	49
6.2.	Holding time as an unsuitable measure of evaluating engagement.....	50
6.3.	Factors of the physical, personal, and sociocultural contexts that influence visitors' engagement levels.....	50
6.3.1.	Physical context	50
6.3.2.	Personal context	51
6.3.3.	Sociocultural context.....	51
6.4.	Limitations of the study.....	52
7.	Conclusion and Implications.....	54
	Reference list	56
	Appendix 1. Interview questions at stage 1: Accompanied visits	61
	Appendix 2. Interview questions at stage 2: Observations and short interviews.....	62
	Appendix 3. Tables of classified codes for individual exhibits.....	63
	Re:Heritage	63
	What Do You Think about Sustainable Consumption?.....	63
	Cups	64
	Change	65
	Smart Map.....	65
	Robot.....	66
	Dark Room.....	67
	Leave Your Own Examples of Sustainability.....	67
	Climate Vision	68

List of Figures

- Figure 1. Elements of the Contextual Model of Learning by Falk and Dierking (2000). 23
- Figure 2. Re:Heritage exhibit..... 26
- Figure 3. What Do You Think about Sustainable Consumption exhibit. 26
- Figure 4. Cups exhibit..... 27
- Figure 5. Change exhibit..... 28
- Figure 6. Smart Map exhibit. 28
- Figure 7. Robot exhibit. 29
- Figure 8. Dark Room exhibit. 30
- Figure 9. Leave Your Own Examples of Sustainability exhibit. 30
- Figure 10. Climate Vision exhibit..... 31
- Figure 11. Visitor engagement profiles for the analysed exhibits. 40
- Figure 12. Median holding times for the analysed exhibits..... 41

List of Tables

Table 1. Keywords used for the literature review.....	11
Table 2. Visitor Engagement Framework (VEF).....	14
Table 3. Participant at Stage 1: Accompanied visits.....	32
Table 4. Participant at Stage 2: Observations and short interviews.....	33
Table 5. Visitor Engagement Framework adapted for the Human Nature exhibition	39

1. Introduction

“You type in your answers and you engage. It makes you stay, I like that. At least that made me stay. It’s more engaging when you can interact. So that’s only that part, not actually the robot itself” – said Oscar, a participant in the present research, after interacting with one of the digital exhibit displayed at the Human Nature exhibition in the Museum of World Culture (Gothenburg, Sweden). Oscar brings up several important concepts in the museum studies that will guide the present research: engagement, digital technology, and interactivity.

The Museum of World Culture states that among its core activities attention is given to visitors’ experience and learning from the content that is thought-provoking and arouses curiosity (National Museums of World Culture, n.d.). This focus on visitors as active creators of meaning rather than passive consumers of one-for-all museum content has become a priority in the museum practice in recent years (Meecham & Stylianou, 2012). As it is the visitors who decide what they want to gain from their museum experiences, understanding their interactions with exhibits as well as their needs and motivations is seen as a primary way to improve exhibitions (Lanir et al., 2017). Visitors’ engagement with exhibits, which is generally defined as paying attention, being focused, and enjoying the process of interaction, has become a state that researchers and museum professionals are looking for when they examine visitor-museum and visitor-exhibit interactions. Moreover, engagement is widely discussed in connection to learning, which is also one of the vital missions of museums (e.g. Harvey, Loomis, Bell, & Marino, 1998). Researchers argue, that visitors’ engagement with exhibits may facilitate or lead to learning (Barriault & Pearson, 2010), and that if a visitor is engaged with an exhibit long enough, then learning takes place (Shaby, Assaraf, & Tal, 2017). Therefore, it is not surprising that prompting and supporting engagement among visitors has become a top-one priority in museum practice. At the same time, the understandings of engagement differ from one research to another, and thus the methods of evaluation engagement are also very varied (Halverson & Graham, 2015). The preliminary literature review identified two most widely-used methods of evaluating engagement with exhibits: analysis of holding time (the duration of visitor’s interaction with an exhibit) as a part of the timing and tracking method and the Visitor Engagement Framework, thus these methods are discussed in details further on.

One of the ways to promote and support engagement among visitors is through introducing digital technologies and interactive exhibits into the museum practice (Del Chiappa, Andreu, & Gallarza, 2014; Holdgaard & Simonsen, 2011; Pallud, 2017). The Museum of World Culture states that digitalization is one of its core activities (National Museums of World Culture, n.d.). According to some researchers, digital technologies are perceived as being flexible, popular, and increasing the accessibility of a museum (Olesen, 2016). Up to the present moment, there have been multiple research projects done in engagement with digital technology in museums. It substantially covers such areas as digital guides, AR technologies, and other digital materials that accompany museum objects and support knowledge transfer (Chang et al., 2014; Damala, Hornecker, van der Vaart, van Dijk, & Ruthven, 2016; Eghbal-Azar, Merkt, Bahnmueller, & Schwan, 2016). However, digital technologies are not welcomed unanimously. Some museums professionals are concerned that the excitement about technology in museums is short-lived and does not necessarily translate into the deep involvement with the content of the museum (Meecham & Stylianou, 2012).

Another trend in research refers to the concept of interactivity, which usually implies the usage of some technology that responds to the user’s actions. Interactivity has proven to make visitors state longer, rate an interactive exhibit as more enjoyable, and recollect more details of their experience after the visit, and thus is considered to be a way to stimulate engagement (Allen, 2004; Schwan, Grajal, & Lewalter, 2014). However, most of the existing research on interactive exhibits focus on children and science centres (Hooper-Greenhill, 2006).

To sum up, promoting visitors' engagement has become of paramount importance for museum professionals. It is pursued via the implementation of digital technologies and interactive exhibits. However, there is still a lack of unified understanding of engagement in the museum context. Thus, methods used to track and evaluate engagement also vary and are often used in isolation. Besides, since a large number of research projects were focused on children's experience in science centres, it is not clear if the conclusions from these studies can be applied in other contexts. Hence, this research aims to contribute to the discussion of the nature of engagement with interactive digital exhibits and methods that can be used to evaluate engagement in museums other than science centres on the example of the Museum of World Culture located in Gothenburg, Sweden, and the recently opened exhibition entitled Human Nature.

Moreover, since engagement is often conceptualized as an interaction between visitors and attributes of an exhibition (Dindler & Iversen, 2009), the levels of visitors' engagement depend on both visitors' personal background as well as the aspects of the museum environment. Examining the factors that encourage or hinder engagement in museums may provide more practice-oriented implications for the museum community and help to understand ways to improve an exhibition (Shaby et al., 2017). There is an extensive number of studies that cover factors influencing visitors' engagement with exhibits (e.g. Barriault & Pearson, 2010; Pallud, 2017; Shaby et al., 2017). However, whether or not a specific factor is considered to influence engagement depends on how engagement is conceptualized and evaluated in a particular study. Thus, after looking into methods of evaluating engagement, I will also examine the factors that may impact visitors' engagement with digital interactive exhibits in the Human Nature exhibition and group them according to the Contextual Model of Learning, which is described in the Theoretical Background chapter.

Consequently, this research will attempt to answer the following research questions:

RQ1: Can the Visitor Engagement Framework and/or the analysis of holding time be used to evaluate the engagement of adults with digital interactive exhibits in a museum?

RQ2: What personal, sociocultural or physical factors impact visitors' engagement levels?

Answering the posed questions will contribute to the understanding of the complex and multifaceted phenomenon of engagement in museums, as well as shed some additional light on the opportunity of digital interactive exhibits to instigate and support visitors' engagement. It may also contribute to the development of the unified method of evaluating engagement, that is vital for comparing results across studies. Additionally, the results may inform the further implementation of digital interactive exhibits in similar museum settings.

In accordance with the stated research questions, the present study has the following structure. The first chapter consists of presents the literature review covering the main concepts relevant for the present study. Namely, the phenomenon of engagement in museums is unpacked, then timing and tracking and the Visitor Engagement Framework are discussed as methods of evaluating engagement. Further, factors influencing engagements are presented. And finally, operational definitions of the key concepts, i.e. the engagement of a visitor with an interactive digital exhibit, and an interactive digital exhibit, are developed. The second chapter presents the Contextual Model of Learning as a theoretical framework for this research. Following this, the third chapter describes the setting for the study, methods of data collection and analysis, as well as related ethical considerations. Findings are presented in the fourth chapter and are structured in accordance with the research questions. The fifth chapter includes the discussion of results and potential limitations of the study. Conclusions, implications, and suggestions for future research are presented at the end.

2. Literature review

This chapter presents a review of relevant literature on engagement in a museum context. First, it outlines the present state of research regarding the definition of engagement in museums and uncovers the lack of unified understanding of engagement. Then, several methods of tracking and measuring engagements are introduced. Afterwards, following the Contextual Model of Learning discussed in the Theoretical Background chapter, the literature will be examined to identify the aspects of physical (e.g. the exhibit characteristics), personal (e.g. previous knowledge, and interests) and sociocultural (e.g. interaction with companions) contexts that may impact engagement in with museum exhibits. Finally, the definitions of engagement and interactive digital exhibits are presented to guide the subsequent parts of the present research.

The keywords used in the search for the literature review are presented in Table 1. The search was restricted to peer-reviewed articles, written in English with available full text. The overall number of articles included in the literature review is 41.

Table 1.

Keywords used for the literature review

Related to engagement	Related to museum	Related to technology
Engage*	Museum*	Technology
Immersion	Exhibit*	Digital
Flow	Gallery	Interactive
Attention	Art	Screen
Museum Fatigue	Heritage	
Timing / time / holding time		

While this study examines the case of the Human Nature exhibition of the Museum of World Culture (Gothenburg, Sweden), the literature review covers research on engagement in all types of museums, including art, history, and most commonly science museums. Additionally, while in this study is focused on adult visitors, the literature review includes research with both adults and children as participants. The rationale behind this inclusive nature of the review is that examining school students' behaviour and interactions in science centres has been a widely discussed topic in museum studies (Hooper-Greenhill, 2006), and excluding those articles from the analysis may deprive this study of important references regarding engagement.

The present study focuses on the digital interactive exhibits, however, the literature review includes discussion of both digital and non-digital, interactive and non-interactive exhibits. This is due to the fact, that some exhibit characteristics (e.g. narrative) contributing to engagement are not bound to a specific modality. Additionally, personal background and interests may also contribute to engagement both with digital and non-digital exhibits. By including a wider scope of research, I aim to get a comprehensive overview of how engagement was interpreted and measured in the related literature, and what factors may encourage or constrain engagement.

2.1. Reviewing definitions of engagement

Azevedo (2015) argues that “engagement is one of the most widely misused and over-generalized constructs found in the educational, learning, instructional, and psychological sciences” (p.84). While engagement is treated as a central aspect in a variety of research papers (e.g. Bailey-Ross et al., 2016; Dindler, Iversen, & Krogh, 2011; Hillman, Weilenmann, Jungselius, & Lindell, 2016; Iversen, & Krogh, 2011; Jewitt, 2012; Schreiber, Pekarik, Hanemann, Doering, & Lee, 2013), the examined literature does not contain a unified understanding of engagement in a museum context. However, certain trends can be identified: engagement of a museum with the public (e.g. Ashley, 2014) and engagement of a visitor in a museum (e.g. Dindler et al., 2011). From both perspectives, engagement is a prerequisite for improving the relations between a museum and society (Ashley, 2014). Engagement of a museum with the public implies attracting and retaining the audience, ensuring impact, etc. (Ashley, 2014). Engagement of a visitor in a museum has been explored at different levels: engagement with a specific museum throughout one’s life (Everett & Barret, 2009), and engagement with an exhibit (e.g. Barron & Leask, 2017) or specific technology, e.g. mobile guides or interactive kiosks (e.g. Pallud, 2017). For the purpose of this study, I will focus on the engagement of an individual with specific exhibits.

The phenomenon of visitors’ engagement with exhibits is also not clearly defined, but most often operationalized through the measures that are used to assess it or through the expected outcomes (Halverson & Graham, 2015). The discussions of engagement are centred around the following ideas: (1) engagement is manifested through visitor’s behaviour and participation (e.g. activating the exhibit, discussing it with others, accessing additional information), and holding time (the time a visitor spends with a particular exhibit); (2) engagement is usually associated with immersion, enjoyment, and interest; (3) engagement is not a state but a continuum, so it is possible to be more or less engaged; and (4) engagement may lead to deeper learning and conceptual change (Barriault & Pearson, 2010; Eghbal-Azar et al., 2016; Serrell, 1997; Shaby et al., 2017). Engagement is also discussed as similar to the flow state (Harvey et al., 1998; O’Brien & Toms, 2008). For instance, Pallud (2017, p.468) defines cognitive engagement as “state of deep involvement and enjoyment for an individual in a learning situation” that comprises attention focus or immersion, enjoyment, and curiosity.

What follows from this brief overview is that the few existing interpretations of engagement are rather broad: researchers discuss behavioural expressions such as participating, affective signs of enjoyment, and cognitive outcomes such as conceptual change. A suitable concept for structuring those varied understandings is outlined in the seminal literature review by Fredricks, Blumenfeld, and Paris (2004). The authors outline the multifaceted concept of engagement in a school context as having three dimensions – behavioural, cognitive, and emotional – that are united in a meaningful way. *Behavioural engagement* is grounded in the observable participation in activities. It ranges from just completing the task to doing more than required (Fredricks et al., 2004), and includes socio-behavioural engagement, e.g. interaction with peers, participating in discussions, asking questions, explaining ideas to others (Fredricks et al., 2016). *Emotional engagement* includes positive and negative affective states, i.e. happiness, sadness, anxiety, boredom, frustration, interest, being overwhelmed, tired (Boekaerts, 2016; Fredricks et al., 2004). *Cognitive engagement* refers to the level of cognitive investment into learning, including being self-reflective, strategic, trying to understand ideas and relate them to previous knowledge, etc. (Fredricks et al., 2004). Fredricks et al. (2016) also added the social-cognitive perspective, that includes understanding different perspectives and building off other people’s ideas. Fredricks et al. (2004) highlight different possible relations between dimensions. For instance, it can start with emotional (e.g. liking the activity) and/or behavioural engagement (e.g. participating) and lead to a high level of cognitive engagement (e.g. deep involvement that enhances learning).

2.2. Measuring engagement

Since my research aims to explore how engagement with interactive digital exhibits can be evaluated, this section reviews the two most widely used methods, namely timing and tracking and the Visitor Engagement Framework (VEF).

2.2.1. Timing and tracking

Timing and tracking is one of the highly used methods in visitor studies combining both time assessments and observation of visitors' behaviours. Yalowitz and Bronnenkant (2009) in their highly cited literature review state that this method of observing museum visitors dates back to the early 20th century, and has become a widely accepted method to identify the most attractive exhibits. It helps to evaluate the successfulness of an exhibition among visitors, inform future design of exhibits, and set expectations about visitors' levels of engagement. The authors define timing and tracking as "following and recording visitor behaviour in an area larger than a single exhibit component, usually an exhibition" (Yalowitz & Bronnenkant, 2009, p. 49).

The variables that often used in timing and tracking are (1) stopping behaviour, i.e. the total amount of time an observed visitor spend in the area, the time for which he/she attends to specific exhibits (holding time), the number of stops, proportion of visitors who stop at specific exhibits (attracting power), etc.; (2) other behaviours, including visitor routes and social interactions; (3) observable demographic data (estimated age, number of adults and children in the group); (4) situational variables, such as level of crowding, month, day of the week, time, etc. (Sandifer, 2003; Yalowitz & Bronnenkant, 2009).

In this study I will focus on the holding time variable, because other types of stopping behaviour variables as well as looking at visitors' routes are more suitable for analysing visitors' experiences in the whole exhibition or museum, and not for looking at interaction with individual exhibits. As for the other variables, such as social interactions and observable demographic data, they are not specific for this method, rather they exist across different approaches including the VEF.

Furthermore, the analysis of the holding time has been frequently used independently of other variables mentioned in timing and tracking: longer holding times are usually associated with higher engagement (e.g. Eghbal-Azar et al., 2016; Myrczik, 2014). Meanwhile, the decreasing time of interaction with exhibits is often a sign of museum fatigue, which is defined a predictable decrease in visitors' attention and interest during the visit or across successive exhibits (Davey, 2005; Kim, Dillon, & Song, 2018). Sandifer, C. (2003) says that a visitor is considered to be engaged with an exhibit when she or he spent at least five seconds (a) examining the exhibit (which included reading), (b) interacting with the exhibit (i.e., manipulating, touching), or (c) watching another visitor interact with the exhibit. Holding time is also mentioned at the highest level of engagement in the Visitors Engagement Framework, discussed below (see section 2.2.2). Important to note, that while time assessments provide a general quantitative data about visitors' attention, some researchers now question the validity of this method, since just the mere fact that a visitor stands in front of the exhibit does not necessarily tell us about the quality of this experience (Falk, Dierking, & Adams, 2006).

2.2.2. Visitor Engagement Framework

Barriault and Pearson (2010) present the Visitor Engagement Framework (VEF), that is based on the Contextual Model of Learning (Falk & Dierking, 2000) and constructivist thinking (Hein, 1998). The framework constitutes a part of the tool for science centres to assess the effectiveness of exhibits to engage visitors in a learning experience. The researchers state that engagement is a continuum, and that a higher level of engagement is an indicator of learning. The framework contains three levels of engagement that are distinguished based on corresponding behaviours. The levels are (1) initiation behaviours, (2) transition behaviours, and (3) breakthrough behaviours (Table 3). This framework allows to quantify engagement and create an engagement profile of the exhibit, that can be used to assess its effectiveness, then make changes and assess the results.

Initiation behaviours refer to doing the activity suggested by an exhibit and/or watching others doing the activity. These behaviours, being at the first stage of the learning experience, allow visitors to get an initial understanding of what the activity is about and whether the outcome is worth their time and effort. *Transition behaviours* include repeating the activity and expressing positive emotions about the interaction with an exhibit. *Breakthrough behaviours* entail referring to past experiences during the activity, seeking and sharing information, and being “engaged and involved” (Barriault & Pearson, 2010; p. 96). It is said that visitors’ interactions with an exhibit at this stage become meaningful learning experiences, as these behaviours demonstrate that a learner recognizes the relevance of the activity and constructs one’s own understanding of the presented concept. Shaby et al. (2017) further extended the VEF in their observational study of 1800 students aged 10-12 on a school visit to the science centre. Two additional behaviours were added to the seven of the original framework, namely 'expressing negative emotions' in Initiation behaviours and 'asking others, consulting' in Transition behaviours (Table 2).

Table 2.

Visitor Engagement Framework (VEF)

Learning behaviour	Type of activity (Barriault & Pearson, 2010) <i>Additional items added by Shaby et al. (2017)</i>
Initiation behaviours	
1. Doing the activity	<ul style="list-style-type: none"> • In passing, not done completely • Doing the activity somewhat completely • Doing the activity without further exploration or testing of variables
2. Spending time watching others engaging in activity or observing the exhibit	<ul style="list-style-type: none"> • Looking at the exhibit working, or someone doing the activity • Watching the exhibit or person using exhibit with expressed interest in the activity (facial expression or verbal) • Interested in learning outcome or in learning the activity; visitor does the activity after observing
3. <i>Expressing negative emotional response in reaction to engaging in activity</i>	<ul style="list-style-type: none"> • <i>Displeased with the exhibit, making negative remarks</i> • <i>Leaving the exhibit after a short experience or after watching others engage, showing marks of displeasure</i>
Transition behaviours	
4. Repeating the activity	<ul style="list-style-type: none"> • Doing the activity two to three times to attain the desired outcome, to master the exhibit’s function • Enjoyment of outcome • Changing the variables once looking for a difference in outcome; becoming involved/engaged
5. Expressing positive emotional response in reaction to engaging in activity	<ul style="list-style-type: none"> • Smiling, pleased with exhibit • Stronger signs of enjoyment such as laughter; verbal references to enjoyment • Obvious signs of eagerness to participate; excited disposition;

6. <i>Asking others, consulting</i>	<ul style="list-style-type: none"> • <i>Asking questions regarding the operation of the exhibit or the outcome</i> • <i>Making general comments about the operation</i> • <i>Not necessarily waiting for an answer</i>
Breakthrough behaviours	
7. Referring to past experiences while engaging in the activity	<ul style="list-style-type: none"> • Reference to past experience with exhibit or science centre • Simple reference to comparable experience in visitor's life • Reference to comparable experience in their life as well as making comparisons and deductions based on observations of similarities and differences
8. Seeking and sharing information	<ul style="list-style-type: none"> • Calling someone over to look at exhibit, or to ask them to explain an exhibit; asking a question to staff or family member without lengthy discussion or exploration of topic. Reading signage; having conversations about exhibit and related science with staff or family members • Sharing experience and information with others by explaining the exhibit to them, giving them details about gained information and observations; discussions and questions about exhibit with staff or family member/friend
9. Engaged and Involved: testing variables, making comparisons, using information gained from activity	<ul style="list-style-type: none"> • Engaging in inquisitive behaviour, exploratory actions such as repeating the activity several times, reading signage, asking questions; remaining on task for 2–3 minutes • Concentration and motivation are obvious; doing the activity as a means to an end, or meeting a challenge; length of interaction significant, 3 to 5 minutes; outcome or result of activity important • Experimenting, testing different variables, looking for different outcomes; engages in discussion with others (visitors or staff) about the various outcomes; experience— 'flow'; involved in activity for long period of time i.e. more than 5 minutes

Note. Data is taken from the original framework by Barriault and Pearson (2010), and modifications suggested by Shaby et al. (2017), which are marked in italics.

After the levels of engagement are recorded it is possible to create a Visitor Engagement Profile of an exhibit. Each of the levels is represented by a bar showing the percentage or number of visitors who demonstrated the behaviours related to a certain level (Barriault & Pearson, 2010). It is important to note, that this instrument does not assess the attraction power of exhibits, as it only includes those visitors who stop and pay attention to the exhibit (Initiation behaviour is always 100%). Barriault and Pearson (2010) suggest that Visitor Engagement Profiles can be used by museum professionals to analyse visitor-exhibit interaction. Exhibits that aim to induce learning but generate low Transition and Breakthrough score may be considered unsuccessful.

2.3. Factors influencing engagement

In order to answer the second research question, an overview of the literature regarding the factors that may influence engagement is presented further in order to answer the second research question

regarding the aspects of personal, socio-cultural, and physical contexts that may have an impact on visitors' engagement with exhibits.

2.3.1. Exhibit characteristics influencing engagement

2.3.1.1. Interactivity

Interactivity can be interpreted as physical interactivity, i.e. the ability of an exhibit to react to visitor's actions. It usually means that there is some technological device involved, and a visitor can operate it through physical activity (Witcomb, 2006). Research has demonstrated that interactivity is important in promoting engagement and understanding, it has proven to make visitors stay longer, rate an interactive exhibit as more enjoyable, and recollect more details of their experience after the visit (Allen, 2004; Schwan et al., 2014). Pallud (2017) argues that interactivity, i.e. "the extent to which users can participate in modifying the form and content of a mediated environment in real time" (p.469) positively influences the cognitive engagement (understood in the article as immersion, enjoyment, and curiosity) among visitors to the French National Museum of the History of Immigration. Similarly, Skydsgaard, Møller Andersen, and King (2016) found that physical interactivity (e.g. pressing the button) was perceived as engaging by school students visiting a science museum, as they compared it to a traditional museum where visitors are not allowed to touch anything. However, Allen (2004) argues that interactivity should not be considered as obligatory for learning, and that a powerful museum experience can be created without it.

Another interpretation of interactivity involves dialogic interactivity. It follows the lines of constructivism and refers to exhibits that try to connect with visitors by representing aspects of their cultural or social backgrounds. In such a manner a connection with the audience is established based on the reference to their experience (Skydsgaard et al., 2016; Witcomb, 2006).

2.3.1.2. Participation

Participatory museum concept represents a museum as a place to express views and share knowledge with others, and sees visitors as active participants contributing to a museum, rather than passive consumers (Simon 2010). Participation addresses the public dissatisfaction with the authoritative voice of museums, and offers visitors a legitimate way to share their opinions, feel like respected participants, contribute to the museum and connect with others (Simon, 2010). Skydsgaard et al. (2016) see participation, such as sharing visitors' opinions via post-it notes and reading others' opinions, as a part of their discussion about dialogic interactivity. It is an important part of meaning-making and constructing new knowledge that can promote reflection and discussion among visitors (Falk & Dierking, 2000).

2.3.1.3. Ease-of-use

Ease-of-use or immediate apprehendability as it is called by Allen (2004) refers to the exhibit characteristic that enables visitors to understand its purpose and properties without excessive cognitive effort. It allows visitors to focus on meaningful parts of the exhibit instead of trying to figure out how to use it. Therefore, it is an important aspect of an interactive digital or non-digital exhibit that contributes to stronger engagement, increased immersion, enjoyment, and curiosity (Myrczik, 2014; Pallud, 2017; Shaby et al., 2017). The concept of immediate apprehendability shares similarities with requirements for entering the state of the flow (Csikszentmihalyi & Hermanson, 1995), in which the activity has to have a clear set of rules and goals (Allen, 2004; Sandifer, 2003).

In addition to employing user-centred design decisions, such as natural mapping or standardizing (Allen, 2004; Norman, 2006), the ease-of-use can also be achieved by appealing to familiar concepts and activities, and thus relying on visitors' prior knowledge and experiences (Allen, 2004; Shaby et al., 2017). For instance, Shaby et al. (2017) in their study of 1800 students aged 10-12 on their visit to a science centre identified, that the Bicycle exhibit, where 2 participants paddle the bicycles in a race and see the amount of burnt calories, was one of the most successful exhibits. The progression from Initiation behaviours (n=281) to Transition behaviour (n=229) was exceptionally high. Authors

suggest that the positive reaction was caused by the fact that paddling a bike is an understandable daily-life activity, and thus students easily understood the goal of the exhibit and how to operate it. Referencing to past experiences, which is a category at the Breakthrough level, was also high for this exhibit supposedly for the same reason of familiarity and relatedness. On the contrary, the Air Pressure exhibit, which was not intuitively understandable, was far less successful (n=264 at the Initiation behaviour level, only 51 at Transition level, and 10 at Breakthrough level), and led to boredom and frustration (Shaby et al., 2017).

2.3.1.4. Conceptual coherence

While the ease-of-use mainly refers to the technical aspect of manipulating the exhibit, the notion of conceptual coherence means that visitors can understand connections among exhibits and the overall theme of the exhibition. Allen (2004) argues that conceptual coherence is a state that is challenging to achieve especially if the exhibition theme is rather abstract (e.g. feedback), yet it is important for evoking visitors' intrinsic motivation. At the same time, Allen (2004) also notes that there are no answers about how visitors can be encouraged to make connections between exhibits and understand the overarching concept.

2.3.1.5. Affordances for social interaction

Shaby et al. (2017) note that social interactions around exhibits positively impact visitors' engagement in a science centre. These interactions can be in the form of competition as in the bicycle race exhibit, or collaboration, when two people are needed to activate the exhibit. Social interactions can also provide more resources to interpret difficult exhibits. An example from the study by Shaby et al. (2017) is the Drops and Hits exhibit that was designed for 2 simultaneous users who should cooperate to achieve the goal. Even though the exhibit was not easy-to-use, the support and encouragement resulting from social interactions induced the transition to higher levels of engagement. Meanwhile, the Air Pressure exhibit, that was designed for individual use and was not intuitively understandable, was the least successful one from those mentioned in the study in terms of progression from Initiation behaviour to higher levels (Shaby et al., 2017).

2.3.1.6. Providing new information

The novelty and interestingness of information are assessed by visitors, when they make a decision if the outcome of interacting with the exhibit is worth their energy and time (Schwan et al., 2014). However, new information does not always lead to increased engagement. For example, Schreiber et al. (2013) in their discussion of engagement and subsequent conceptual change as a potential outcome of museum experience note that when visitors come to a museum they intend to reconfirm their attitudes and values. Besides, they may be more or less committed and satisfied with their current knowledge. If they are very committed to their current knowledge, and the information is in line with it, then little or no conceptual change happens. An example of this instance is given by Skydsgaard et al. (2016): students visiting an exhibition said that it did not prompt any new thoughts because they already knew about the presented issues. On the contrary, if visitors are committed to their existing knowledge, and the new information presented at the exhibition contradicts their views, conceptual change tends not to happen at all. And only if visitors are not satisfied with their current understanding of the exhibit topic, and the presented information is new, as well as comprehensible, coherent, plausible, and rhetorically compelling, then the stronger change is more likely to happen (Skydsgaard et al., 2016).

2.3.1.7. Technological novelty

Another potential way to arouse curiosity is to use technologically novel exhibits. Sandifer (2003) defines exhibit as technologically novel if it contained visible state-of-the-art devices or if it illustrates a phenomenon that cannot be explored by visitors without this technology. The results of his research show that technological novelty correlates with visitor's holding time in the science centre. However, an important discussion between technological determinism and constructivism should also be taken into consideration here. Olesen (2016) discusses this distinction based on interviews with museum

professionals. She stated that, on the one hand, there is strong excitement about technology as a must-have in a modern museum, and some museum professionals talk about technology as an essential prerequisite to get funding and attract audience. On the other hand, a growing number of museum professionals argue that technology just for the sake of technology is not an acceptable approach, as excitement about technology is short-lived and fleeting (Olesen, 2016). It may attract attention, but it cannot guarantee deep engagement and learning. Following the constructivist ideas, technology should only be introduced if it is relevant to the specific museum context, and can provide a meaningful experience for visitors (Olesen, 2016).

2.3.1.8. Narrative

Personal narrative is defined as personal storytelling that contains personal viewpoint and event sequence. (Allen, 2004; Skydsgaard et al., 2016). It has been an important mode of exhibit presentation in historical and cultural museums (e.g., Bedford, 2001; Rounds, 2002). Skydsgaard et al. (2016) refer to personal narratives as effective tools in arousing reflection and discussion. According to their research, many students (53%) mentioned narratives in their interviews regarding an exhibition about the human body, because they were able to identify themselves with the authors of those narratives. While narratives were successful in the exhibition about social perception of a human body, they were not effective in the science museum, as described by Allen (2004). Visitors there preferred inquiry videos in which they were asked questions and invited to further explore and think about the exhibit and connect it to their prior knowledge.

While Allen (2004) separated narrative from scientific discourse, Skydsgaard et al. (2016) included the notion of expert narratives, i.e. views by the experts in the field, who can provide visitors with understandable and relevant information about the current state of research in the area. The results demonstrate that the expert narratives also attract attention among visitors, but serve as a source of new relevant information, rather than an opportunity for self-reflection (Skydsgaard et al., 2016).

2.3.2. Personal characteristics influencing engagement

Researchers share the opinions that engagement and museum experience depend on the personal context of visitors, their previous knowledge, interests and preferences, expectations, as well as the decisions that visitors make in the exhibition (Falk & Dierking, 2000).

2.3.2.1. Preferences and interests

Exhibits that are personally relevant because of the visitors' profession, hobbies, place of residence, values and attitudes attract and retain visitors' attention (Sandifer, 2003). For example, Insulander and Selander (2009), who examined the engagement of visitors in the Museum of National Antiquities in Stockholm, argue that engagement is caused by relating the exhibit to one's interests and experience. One of the participants engaged with such objects as jewellery and a comb which were relevant to her interests and her profession of a hairdresser.

Additionally, Kim et al. (2018) had an interesting finding in their research about museum fatigue (i.e. a decrease in interest and attention across exhibit) in a science centre. The group of participants who reported a higher level of interest in science demonstrated a lower level of museum fatigue. So, it may be concluded that if visitors are initially interested in the content of the exhibition, they would more likely tolerate some drawbacks of the experience, for instance, if the exhibits are perceived as less interesting than expected.

2.3.2.2. Previous knowledge

As I discussed in the section on new information above (see section 2.3.1.6), previous knowledge and attitudes are connected with such engagement-related concepts as conceptual change, discussion, and reflection (Schreiber et al., 2013; Skydsgaard et al., 2016). Insulander and Selander (2009) also discuss the cognitive engagement of a visitor to the Museum of National Antiquities, who related the content of the exhibition to his previous knowledge about the topic, and was critically reflective about the way that history was represented and explained in the exhibition.

2.3.2.3. Expectations

Visitors' agendas may include not only obtaining new knowledge and skills, but also the needs for recreation, aesthetic pleasure, and socializing. The further developed seminal work by Falk (2011) differentiates between five types of visitors: explorers, professionals/hobbyists, facilitators, experience seekers, and rechargers. Explorers are driven by curiosity and/or interest in the content of the museum. Professionals/hobbyists have job- or hobby-related goals and want to enhance their knowledge. Experience seekers come to the museum because it is an important destination, they may also want to see an exhibit that is well-known or iconic. Rechargers want spiritual or restorative experience, and to have a mental break from the every-day life. And finally, facilitators focus on ensuring that their companions (family or friends) have a satisfactory experience and reach their needs. Schwan et al. (2014) note, that this categorisation is not fixed or exclusive. Visitors can have several agendas simultaneously during one visit or have different agendas about different museums. Another type of categorization was suggested by Sheng and Chen (2012). They analysed 425 questionnaires and identified five types of experience expectations among visitors to Taiwanese museums: easiness and fun, cultural entertainment, personal identification, historical reminiscences, and escapism. Sheng and Chen (2012) found that easiness and fun was the most prominent category among respondents.

Visitors' personal agendas may influence their engagement with digital exhibits in museums. For example, Myrczik (2014) explored how visitors used digital technologies in the National Gallery of Denmark. It is noted that visitors driven by curiosity are especially selective in their choice of exhibits, e.g. they assess the technology and content before using it to decide if the benefits of interaction would outweigh the cost of their time and attention. Interestingly, one of the participants explained her unwillingness to use technology by saying that she preferred to "not being distracted by modern things like computers". The findings also demonstrated that Facilitators tended not to use technology because of the social nature of their visit. Technologies are perceived as disruptive to the experience, because they are intended for individual use, and are perceived as not suitable for a group of people.

2.3.2.4. Control, agency, and decision-making

Control over the task and agency were found to affect the holding time of visitors (Myrczik, 2014; Sandifer, 2003). Having a sense of control over one's actions and the active nature of experience also promote entering the state of the flow, which is a specific form of engagement, when a visitor is fully immersed in the activity that is rewarding in itself (Boekaerts, 2016; Nakamura & Csikszentmihalyi, 2014).

Having control and agency may also refer to the decision-making process, when a visitor chooses if he/she is willing to attend to an exhibit, for how long, and when to disengage. Decision-making is crucial in understanding museum experience (Bitgood, 2009a; Bitgood, 2009b). As a visitor progresses through the exhibition, he/she can make a decision to attend to fewer exhibits than in the beginning. It can result from museum fatigue, e.g. due to satiation (i.e. decrease in attention after being repeatedly exposed to similar stimuli) or physical fatigue (Bitgood, 2009a). However, it can also be understood as a strategically beneficial behaviour. Rounds (2004) notes that visitors typically view only 20% to 40% of an exhibition. He argues that the selective use of exhibits can actually lead to the higher achievement of visitors' goals. Shaby et al. (2017) also note that in a free-choice environment of a museum with multiple alternatives to explore visitors assess the costs and rewards of interaction with an exhibit. So, if they perceive the costs to be too high or the reward too small, they tend to move on to the next more promising exhibit (Bitgood, 2009b).

2.3.3. Sociocultural context influencing engagement

The importance of the social context has been widely discussed in museum studies: it is a part of the contextual model of learning (Falk & Dierking, 2000), the Visitor Engagement Framework (Barriault & Pearson, 2010), and can constitute one of the visitors' agendas (i.e. facilitators, see section 2.3.2.3) (Falk, 2009). It was previously discussed (see section 2.3.1.5) that exhibits which support social interaction among visitors tend to be more emotionally, cognitively and behaviourally

engaging, at least in the science centre context (Shaby et al., 2017). Members of one social group visiting the museum together may interpret and explain exhibits to one another, share ideas and reflections (Briseno-Garzon, Anderson, & Anderson, 2007; Insulander & Selander, 2009).

Schreiber et al. (2013) also add that social context can change visitor's attitude towards the exhibit: if a companion is very much interested or not interested in the topic, the visitor can take the same stand. And on the contrary, if a visitor is rushed by a companion who wants to leave the exhibit sooner, it may lead to a much shorter and less satisfactory visit (Insulander & Selander, 2009).

In their study on museum fatigue Kim et al. (2018) argue that while factors from the personal context are the most wide-spread, the average value of museum fatigue caused by them is the lowest. The highest value is caused by factors from sociocultural context (e.g. "There are too many visitors").

2.4. Concluding remarks and definitions of key concepts

The literature review has demonstrated the wide scope of different ideas united by the umbrella notion of engagement. Drawing on the literature from the formal education context, engagement can be discussed from the behavioural, emotional, and cognitive perspectives. Due to this diversity, the methods used to evaluate engagement also differ. Analysis of holding time primarily addresses the behavioural side of engagement (i.e. interacting with an exhibit, discussing it with companions), while the Visitor Engagement Framework (VEF) takes into account the whole spectrum including not only behaviours but also emotional reactions and cognitive outcomes. At the same time, the VEF also mention the time of interaction as a marker of higher engagement. Therefore, first, the working definition of engagement has been developed to guide the present research (section 2.4.1.). Second, the VEF will be the main framework used in this research to assess visitors' engagement with exhibits, since it provides a more holistic overview of engagement. In addition, the analysis of holding times will also be performed to compare the results and see, if higher levels of engagement according to the VEF correspond to longer holding time.

As for the second research question, the review has outlined a variety of factors that may support or hinder visitors' engagement with digital and non-digital, interactive and non-interactive exhibits in different types of museums. These aspects can be divided into three groups: (1) the characteristics of museum exhibits, (2) the personal characteristics of a visitor, and (3) the sociocultural context including the cultural perception of a museum and the social interactions with the museum. Aspects from different groups may be tightly intertwined, support or inhibit one another. Following this discussion of factors influencing engagement (see section 2.3), a working definition of an interactive digital exhibit, which this study is focused on, was developed (see section 2.4.2). These factors will also inform the further discussion of visitors' engagement with the exhibits at the Human Nature exhibition.

2.4.1. Engagement of a visitor with an interactive digital exhibit

The understanding of engagement, that I will be guided by in this study, is based on the results of the literature review above, and takes into consideration the definition of engagement in education offered by Boekaerts (2016):

Engagement refers to a student's active involvement and participation in school-based activities, more concretely it entails students' reactions to and interactions with the learning material as it is embedded in the physical, instructional and social environment. (p. 81)

and the definition of museum fatigue by Davey (2005):

A collection of phenomena that represents predictable decreases in visitor interest and selectivity either during entire visits, within smaller areas (such as exhibit galleries), or across a few successive exhibits. These changes are likely to be attributed to a combination of visitor factors

(such as cognitive processing, physical fatigue, and individual characteristics), factors in the environment (such as exhibit architecture and the museum setting), and interaction between them. (p. 19)

Hence, the engagement of a visitor with an interactive digital exhibit refers to visitor's behavioural, affective, and cognitive involvement in the activity offered by the exhibit. This involvement results from a free choice made by a visitor, varies in scale, and can be attributed to factors in the environment, visitor's personal context, social environment, and interaction between these factors.

2.4.2. Interactive digital exhibit

Based on the results of the literature review, an interactive digital exhibit refers to exhibits that integrate digital technologies and present opportunities for physical and/or dialogic interaction between a visitor, the exhibit, the audience, and the museum. The physically interactive exhibit can be operated by the visitor through some physical actions and react to these actions. Dialogic interactivity refers to the connection with the visitor that an exhibit tries to establish by appealing to the visitors' experiences, social and cultural backgrounds.

3. Theoretical background

This section presents the Contextual Model of Learning (CML), that was chosen as a theoretical framework for the present research. The model is grounded in the ideas of constructivism and was proposed by Falk and Dierking (2000, p.10) as a “framework for thinking about learning” within such free-choice settings as museums, science centres, etc. The model and the underlying constructivist ideas suit the goal of the present research on engagement, as they allow to explore the multidimensional nature of interaction with exhibits from the perspective of an active visitor who constructs his or her own meaning based on personal, social and environmental factors.

As the CML was chosen to guide this research, it is important to highlight the tight connection between learning and engagement. According to Hooper-Greenhill (2007):

Learning is a process of active engagement with experience. It is what people do when they want to make sense of the world. It may involve increase in or deepening of skills, knowledge, understanding, values, feelings, attitudes and the capacity to reflect. (p.32)

From this perspective, learning can be seen as a result of engagement and simultaneously as its integral part. The higher levels of engagement according to Barriault and Pearson (2010) are related to cognitive learning outcomes. Reflection may hence be treated as cognitive engagement and as a learning outcome of this engagement with an exhibit. Therefore, the learning theory of constructivism and the Contextual Model of Learning provide a suitable frame of reference for the present research on engagement.

First, the main ideas of constructivism and its relevance for the museum learning will be discussed. Second, an overview of the Contextual Model of Learning and its elements will be presented.

3.1. Constructivism

Constructivism has been seen as an appealing theoretical framework for discussing museum experiences, as it matches the free-choice and informal nature of learning in such environments (Hein, 2006). The main idea of constructivism is that learning is an individually and socially active process of constructing meaning based on previous knowledge and experiences (Adams, 2006). Learners make meaning of the world and of themselves through individual processes, such as reflection and abstraction, and social processes, such as negotiation, discussion and collaboration (Doolittle & Hicks, 2003; Packer & Ballantyne, 2016). Unlike behaviouristic views, which posits that it is a museum that decides what the visitors are supposed to learn from an exhibit, constructivist museum acknowledges that the visitor chooses what meaning to make in the museum (Falk et al., 2006). It states that instead of being a passive receiver, every visitor makes a free choice about what and where to learn (Barriault & Pearson, 2010; Hein, 2006). These ideas help to explain how engagement with an exhibit unfolds as a visitor constructs his/her understanding of an exhibit based on the previous knowledge and through individual cognitive and social processes.

3.2. Contextual Model of Learning

According to Falk and Storksdieck (2005), the Contextual Model of Learning is used not to predict, but to describes learning as being contextualised and influenced by personal, sociocultural and physical contexts, that change and interact with one another all the time (Figure 1). According to the authors, it was an effort to create a model to think about learning in museums, take into consideration it's holistic nature, yet give the place to multiple specifics and peculiarities (Falk et al., 2006).

The *personal context* represents a personal experience and history of a visitor and includes five aspects: prior knowledge, motivation and expectation, interests and beliefs, control over one's learning and choice over what and when to learn (Falk et al., 2006). It emphasises the focus on learners and the

idea that they construct meaning differently due to different ways of selecting and interpreting information (Adams, 2006).

Learning always takes place within a *physical context*, which refers to the environment characteristics. The physical context includes architectural and design issues such as the number of exhibits and their characteristics, presentation, lighting and crowding, exhibition hall environment, orientation in physical space, and convenient facilities (i.e. cafe, souvenir shop) (Falk et al., 2006).

Learning in museums is also influenced by the *sociocultural context* on macro and micro levels. On a macro level, visitors' experiences are affected by the culture they live in and how a museum is seen within their community and culture. On a micro-level, the interactions that happen within visitors' social groups (e.g. family or friends who come to the museum together) and interaction between visitors and museum employees also have an impact on visitors' experience in a museum (Falk et al., 2006). This is in line with social constructivism that highlights the social nature of leaning and sees learners as co-constructors of meaning via social interactions (Adams, 2006; Doolittle & Hicks, 2003).

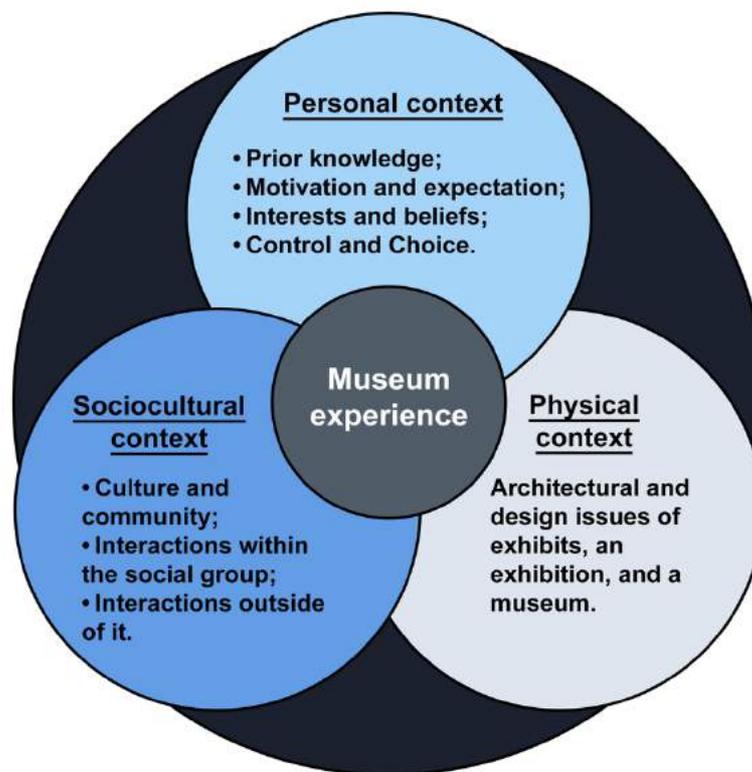


Figure 1. Elements of the Contextual Model of Learning by Falk and Dierking (2000).

The Contextual Model of Learning (CML) was extensively employed in previous studies on engagement in museum settings. For instance, the Visitor Engagement Framework (see section 2.2.2), that is used for evaluating engagement in this study, was developed based on the CML and constructivist ideas. The VEF authors argue that “learning is an active process, an interaction between ideas that learners currently hold and newly presented experiences” (Barriault & Pearson, 2010, p.92). They state that when visitors are demonstrating behaviours of the Breakthrough level of engagement, i.e. seeking and sharing information, referring to the past experience, discussing the exhibit with companions and museum staff, their interaction with an exhibit becomes a meaningful learning experience. Visitors make meaning and construct their understanding of an exhibit by appealing to their prior knowledge and experience, as well as through social interactions.

Not only the VEF authors employ the Contextual Model of Learning when examining engagement. The CML was used to discuss the reasons for museum fatigue (Kim, Dillon, & Song, 2018). Other studies also appeal to related ideas, even though authors do not always mention the CML explicitly. Several researchers argue that engagement may be influenced by the exhibit message, visitors' prior experiences, knowledge and preferences, their familiarity with the environment and the discussed topics, etc. (e.g. Dindler & Iversen, 2009; Pecore, Kirchgessner, Demetrikopoulos, Carruth, & Frantz, 2017; Schreiber et al., 2013).

Within the present research the Contextual Model of Learning allows me to structure and explain the diverse factors influencing engagement with exhibits both in the literature review section, as well as to interpret and organize my own findings. The physical context provides space to speak about the design characteristics of digital interactive exhibits. While the other physical features of the museum, such as lighting or convenient facilities may also influence the museum experience, I mainly focus on the design issues of specific exhibits, as none of other physical characteristics of a museum were mentioned by the participants in reference to their experience with individual exhibits. The personal context allows me to examine the influence of visitors' personal background on their engagement with exhibits, and to look at how participants make choices about which exhibits to attend to and for how long. Finally, the sociocultural context helps to explain if and in what way the interpersonal interactions may influence the engagement of visitors with exhibits.

4. Methodology

This section describes the research design developed for the present study. The chosen design frame is the case study, which is the “in-depth research into one case or a small set of cases” (Thomas, 2017, p.156), and a “unique example of real people in real situations” (Cohen, Manion, & Morrison, 2002, p. 289). It allows me to obtain a detailed rich understanding of the visitor’s experience, and thus better examine the complex phenomenon of engagement in museums. I will use a combination of methods within the case study frame to explore how engagement unfolds in a context of a particular exhibition, as well as how visitors’ personal histories, experiences, and attitudes impact their engagement. By setting up the research in a museum and choosing the data collection method that is the closest to the natural museum visit experience, I also aim to enhance the ecological validity of the study and acknowledge that any obtained data would be contextually situated (Cohen et al., 2002).

First, the description of the setting is presented. Then the data collection and sampling strategies, as well as the data analysis techniques are discussed. Finally, the ethical considerations are outlined.

4.1. Setting

4.1.1. Exhibition

The exhibition under the title Human Nature opened in the Museum of World Culture (Gothenburg, Sweden) in February 2019 and will be on display until May 2020. Afterwards it will be moved to the Museum of Ethnography in Stockholm. The exhibition is devoted to such topics as climate change, extinction of species, and excessive consumption, and aims to inspire a more sustainable lifestyle. The exhibition displays both objects from the museum collection and several ongoing scientific projects. The underlying message of the exhibition is that it is all connected, and the way we live our lives is closely intertwined with the state of the Earth (Human Nature. About the exhibition, n.d.). This exhibition has been chosen for the present research for a number of reasons. First, it presents a rarely researched type of museums. It has already been noted, that science centres usually serve as environments for the research on engagement. Second, the exhibition is rich in technologies of varied types. Additionally, most of the digital artefacts there are not designed as a support for objects from the museum collection, like a digital audio guide would be. Instead, they are stand-alone independent exhibits. So, a visitor does not have to divide one’s attention between the object and the technology, and the engagement with digital exhibits can be examined.

4.1.2. Digital interactive exhibits

In this research, I will focus on interactive digital exhibits in the Human Nature exhibition. Interactive exhibits are regarded from the perspectives of both physical and dialogic interaction. Nine exhibits were chosen for analysis, eight of them are physically interactive, so a visitor can produce a change with one’s actions. One is purely dialogically interactive, which means that it aims to connect with the visitors, but does not offer opportunities for physical interaction.

4.1.2.1. *Re:Heritage exhibit*

Re:Heritage exhibit is an interactive screen with a three-question survey (Figure 2). First, it asks a user to think about an object that the user had for a long time. There are 15 options including tools, art, toys, books, etc. Then it asks “How long have you had this object?”, there are 12 options available. The final question is “Why have you kept this thing?” There are 21 options, including “It gives me respect”, “It’s a memory”, “It says something about who I am”, etc. On every page at the very bottom of the screen it says: “See what others have responded”, that gives a statistical overview of what other people answered for the particular question. After a visitor answers all of the three questions, the message on the screen appears: “Thank you for your help. Your answers have been forwarded to Re:Heritage”.

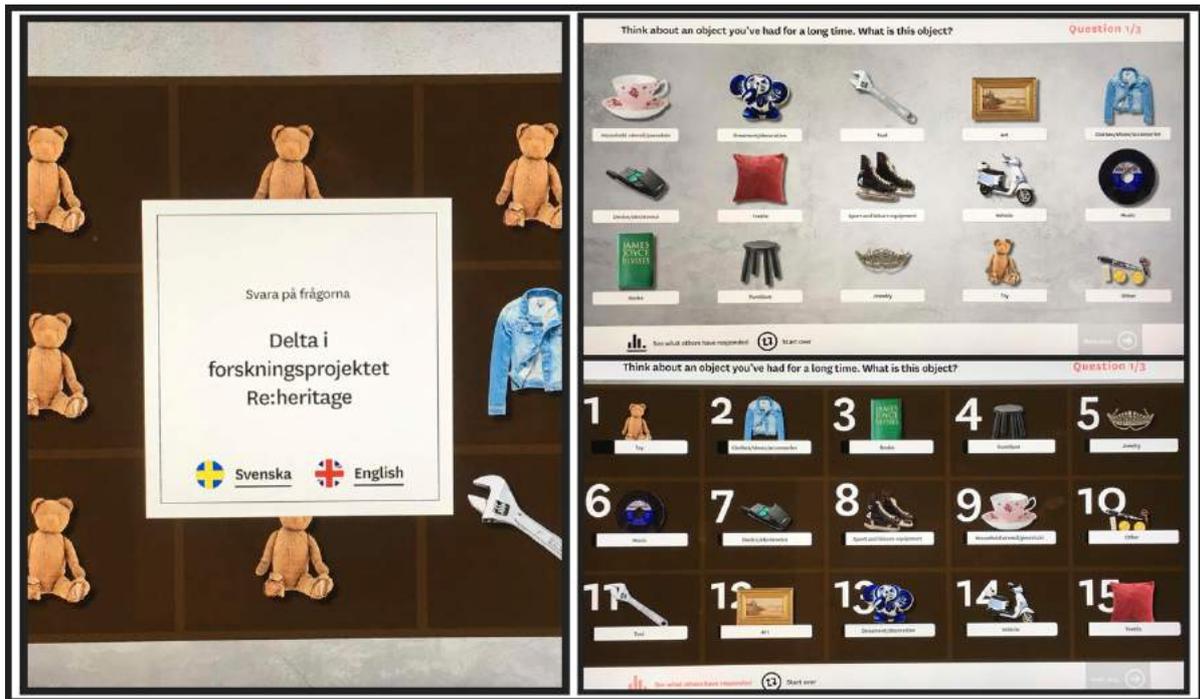


Figure 2. Re:Heritage exhibit.

4.1.2.2. 'What Do You Think about Sustainable Consumption?' exhibit

A similar interactive screen asks visitors to contribute to the research project. The survey includes a number of questions about the respondent's willingness to make sustainable life choices (Figure 3). After answering a series of questions (e.g. "How many times per week are you willing to eat vegan dinners/lunches"), a respondent is offered to answer several additional personal questions (e.g. age, gender, zip code). He/she can also choose if he/she wants to leave an email to be contacted later.

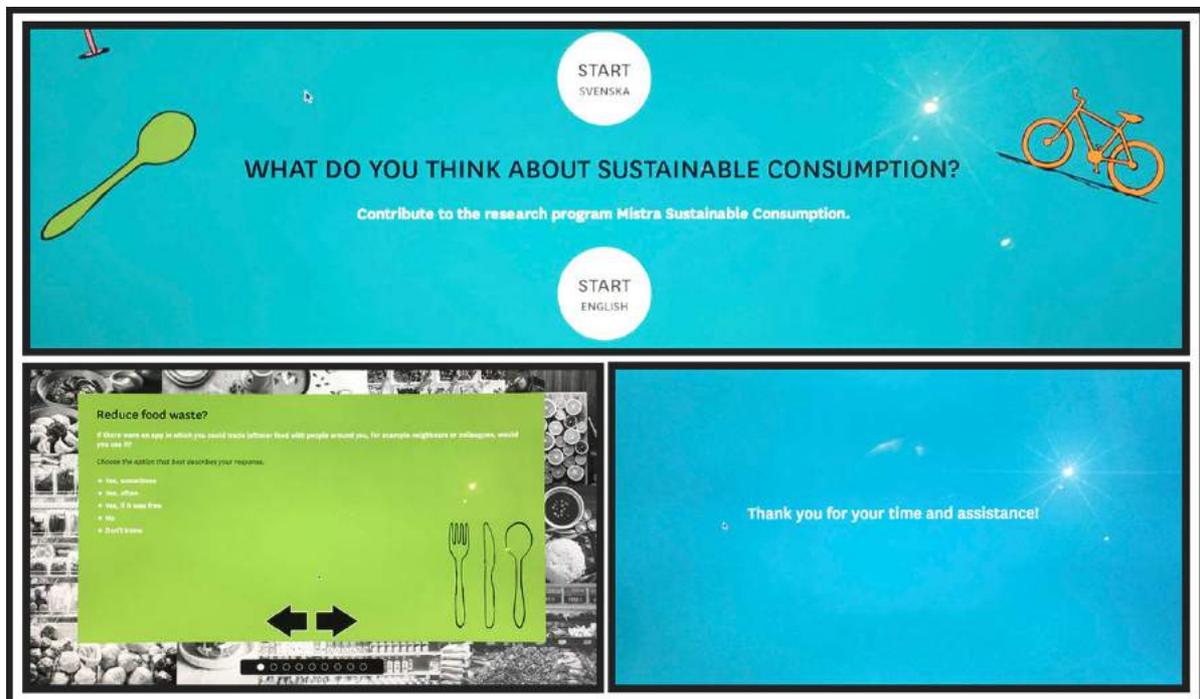


Figure 3. What Do You Think about Sustainable Consumption exhibit.

4.1.2.3. *Cups exhibit*

There are 12 cups located on the oval table with heart-shaped buttons next to every cup (Figure 4). Swedish or English language can be chosen. When pressing one of the buttons next to a cup an audio recording starts playing from the speakers. Every story is narrated on behalf of the previous owner of the cup about how and when a person got this cup, and how gradually it became less and less used. It is not possible to switch to the next cup until the previous story is finished. There is a sign hanging above the table: “Listen to the stories of love that has cooled down”.



Figure 4. Cups exhibit

4.1.2.4. *Change exhibit*

The whole room is devoted to one exhibit. There is a big screen on the wall with a cartoon map of a city (Figure 5). In front of the screen, there is a counter with eight big buttons: “Cleaner water”, “Vibrant countryside”, etc. The intro on the screen explains: a visitor needs to choose what is important for him/her out of those categories. A visitor presses the relevant button and the map zooms in to a particular area of the city. The text on the screen says in English how a particular environment-related decision would make life better, e.g. “By reducing air pollutants, historical buildings and landmarks can last longer and more people can enjoy them.” There is also a loud audio recording saying the same message in Swedish. For every button there are several messages which a visitor can get by pressing the button several times.



Figure 5. Change exhibit.

4.1.2.5. Smart Map exhibit

An interactive screen presents the Smart Map website (Figure 6). Smart Map is a collection of initiatives that exist in the city where the museum is located. The examples include toy libraries, exchange plant initiative, car rentals, etc. A visitor can search and choose the initiative that is personally interesting, and then click to get more information.

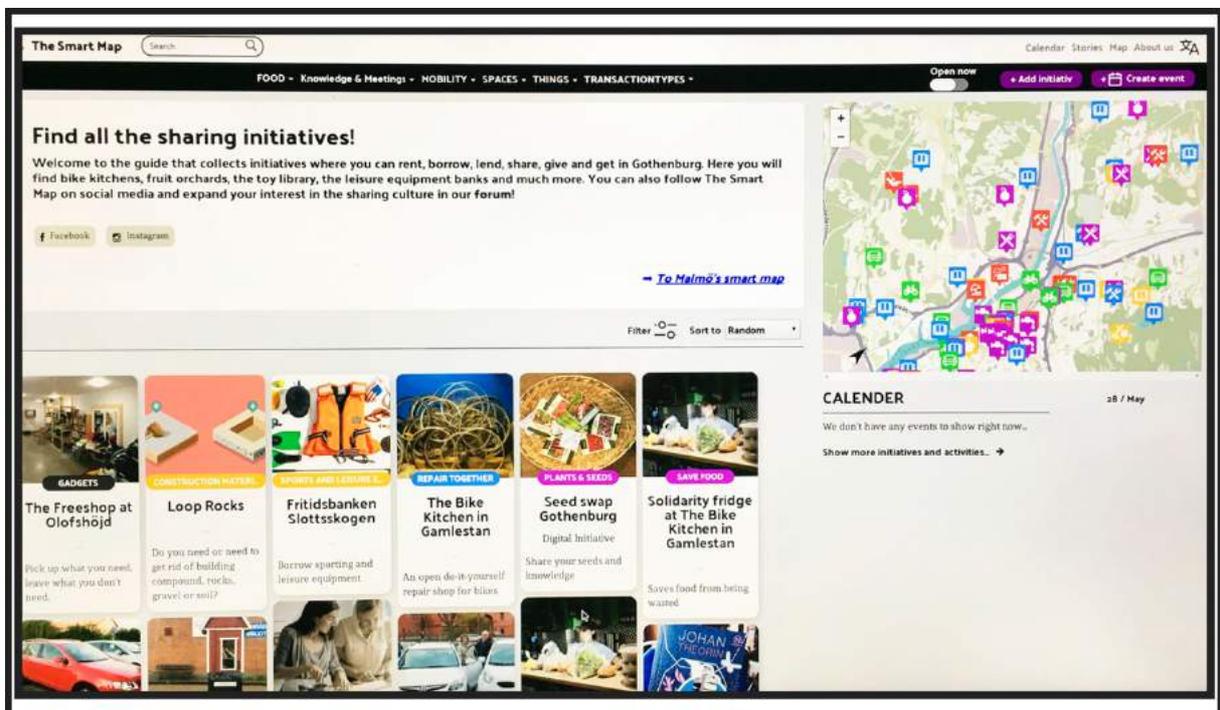


Figure 6. Smart Map exhibit.

4.1.2.6. Robot exhibit

A small room is separated from the rest of the area with a curtain (Figure 7). The sign before the entrance to this room says: “Do you have a broken object that you consider replacing? Do you need time to think? Welcome in! Just one at a time.” Inside the room there is a table with a keyboard and two chairs: one for the visitor, and in another one a human-shaped figure is sitting. The human-like face is projected on this figure’s head. The sign near the visitor’s chair says: “Select your language. Type your answer when the light is on and press enter.” After a visitor chooses the language using the buttons on the keyboard, the robot asks the visitor’s name. A visitor is supposed to type it using the keyboard and then press Enter. Then the robot asks what it is that a visitor wants to replace, and a visitor types the answer (e.g. my phone). The robot asks the visitor to think about the relationships between him/her and the object, how they cared about each other, etc. It is the same recording every time, and the visitor’s name and the name of the object are inserted into this recording. Finally, the robot thanks the visitor for the talk.

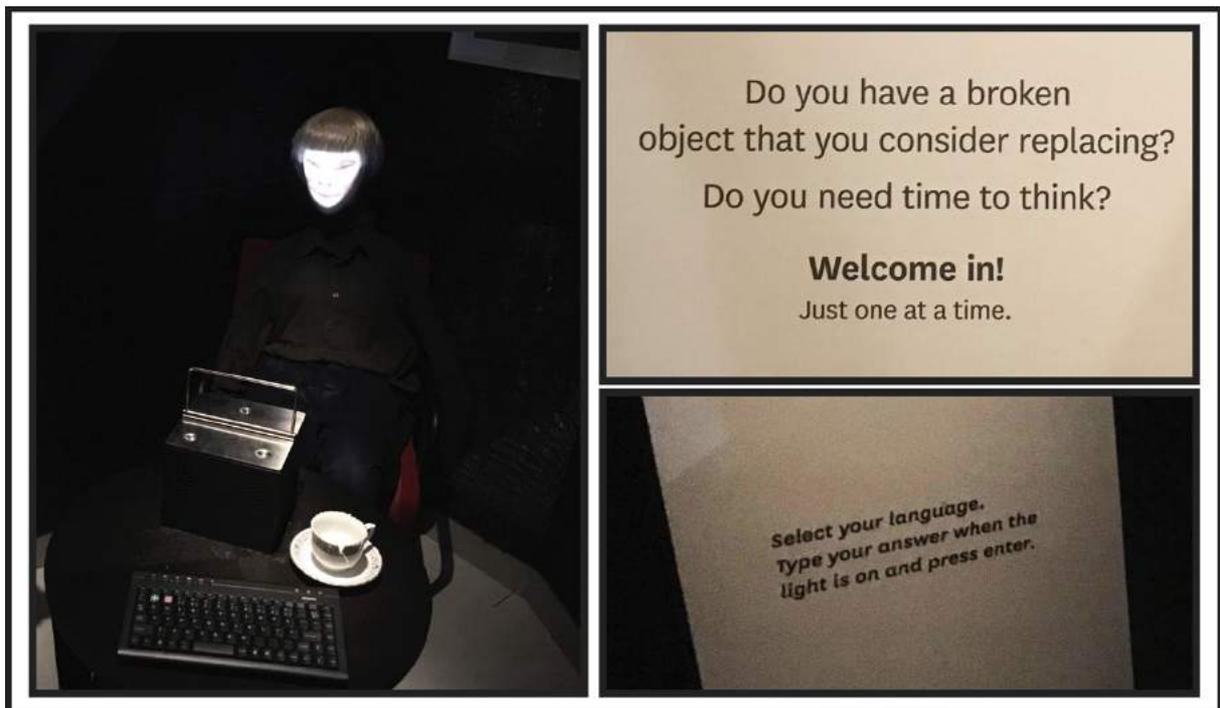


Figure 7. Robot exhibit.

4.1.2.7. Dark Room exhibit in the Emotional Landscapes area

A visitor steps inside a poorly lit room, at the wall opposite to the entrance there is a screen that shows spots of light moving slowly (Figure 8). In front of the screen there are several chairs separated from each other. A visitor puts on headphones and listens to the audio recording. The voice speaks slowly and calmly. It asks the visitor to relax, breath, think about the influence of humans on the environment, what emotions it evokes, etc. It addresses the visitor personally, by using the pronoun ‘you’.



Figure 8. Dark Room exhibit.

4.1.2.8. 'Leave Your Own Examples of Sustainability' exhibit

The interactive screen invites visitors to share their proposals for sustainable lifestyle (Figure 9). A visitor can choose one of the categories: Decoration, Holiday, and Food. Then the visitor types his/her own proposal and posts it. The last ten proposals are simultaneously presented. This exhibit and the next one have the fewest number of participants because for the majority of days that I was present at the museum they were not working. However, it was decided to still include those to the analysis, as they differ considerably from other exhibits.



Figure 9. Leave Your Own Examples of Sustainability exhibit.

4.1.2.9. Climate Vision exhibit

An interactive screen is placed in a relatively secluded area with one chair in front of it (Figure 10). It offers visitors an opportunity to see how changing the lifestyle in Sweden (e.g. switching to electric transport or eating less beef) can influence the amount of carbon dioxide emission per year. It is explained that it is important to minimize this number to prevent a considerable increase in temperature on Earth. A user can bring the bars up and down, and the chart shows how these decisions influence the carbon emission rate. When a user reaches zero CO₂ emission, a notification appears that he/she can start over or continue.

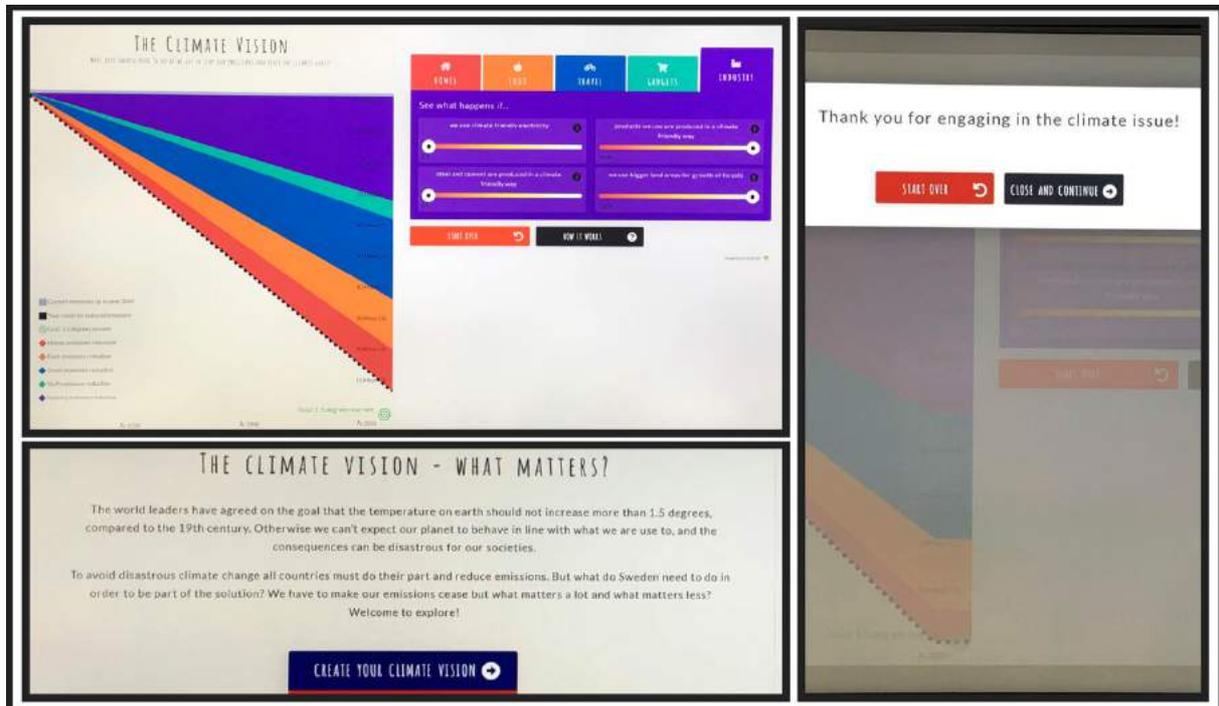


Figure 10. Climate Vision exhibit.

4.2. Participants and data gathering tools

The research comprised two stages: accompanied visits and observations combined with short interviews.

The sampling and data collection strategies differ for those stages and will be discussed separately below. The population addressed in this study are adults (aged 18-35) coming to the museum alone or with companions as a leisure activity, as opposed to guided groups. The age group was chosen because it was more easily accessible, and thus a larger number of participants could be recruited within the limited time frames.

4.2.1. Stage 1: Accompanied visits

For the first stage of the research, the chosen technique of data collection is accompanied visits that draw upon the ethnographic methods of participant observation and associated interviews (Haywood, 2018). It is a method that involves a researcher accompanying visitors on an entire visit to a museum or part of it. Accompanied visits give insights into visitors' experience and their own views of these experiences via analysing naturally occurring activities and conversations (Haywood, 2018). As accompanied visits often combine observation with after-visit interviews, the observation component provides insights into observable behavioural engagement, while interviews help to trace covert signs of emotional and cognitive engagement, and get an in-depth understanding of visitor's expectations,

motivations, interests (Halverson & Graham, 2015). It would be impossible to collect such rich data using only observations, only interviews, or questionnaires.

4.2.1.1. Participants

While usually participants for visitor studies are recruited in the museum itself, participants for the present research (n=10) were invited via posts in several local groups on Facebook. This decision was made based on the nature of the accompanied visit method. While this type of sampling shares potential drawback of a convenience sample model, namely the sample bias, it also presents a number of valuable advantages. Usually, when recruiting participants for accompanied visits researchers approach people at the entrance of a museum, so there is no prior contact with participants that is essential for building rapport, and thus participants may feel uncomfortable and behave differently during the accompanied visit (Haywood, 2018). Additionally, visitors are likely to think that a researcher may be working for a museum, and thus they may be discrete about their real attitudes. By recruiting participant on Facebook I had the opportunity to establish relationships with them beforehand and ensure a friendly visit with minimum disruptions to their experience (Cohen et al., 2002). The pseudonyms, demographic data and social context for the participants at this stage are presented in Table 3.

Table 3.

Participant at Stage 1: Accompanied visits

	Pseudonym	Gender	Age	Social context
1	Emma	Female	20-25	Visit alone
2	Victoria	Female	26-30	Visit together
3	Grace	Female	20-25	
4	Liam	Male	20-25	Visit alone
5	Anna	Female	20-25	Visit alone
6	James	Male	31-35	Visit alone
7	Adam	Male	31-35	Visit alone
8	Elena	Female	20-25	Visit together
9	Oscar	Male	26-30	
10	Andrew	Male	31-35	Visit alone

4.2.1.2. Procedure

Eight accompanied visits took place in February-March, 2019. Each visit and the subsequent interview with the participant(s) lasted 50-90 minutes. Six participants came alone, while the other four came as two dyads. The participants were invited to visit the exhibition with me as companions. I asked them to behave in the same way as they would do had they been there alone or with friends. The participants were encouraged to take as much or as little time as they wanted, stop at any exhibits they would find interesting and ignore others if they wanted to. Participants were not asked to interact with a predefined set of exhibits, because enabling visitors to explore the exhibition on their own provided

me with a more realistic understanding of visitors' experiences, and also was in line with the constructivist ideas of visitors as active participants in control of their own experience.

While some researcher who used accompanied visits chose to 'shadow' the participants and ask them to behave as if the researcher is not there (e.g. Zimmerman, Reeve, & Bell, 2010), for this study I decided to act as an active participant of the visit (e.g. Archer, Dawson, Seakins, & Wong, 2016). This allowed me not only to record behaviours and events, but to also learn the visitors' perspectives by recording their conversations and being a companion to talk to during the visit. Besides, taking an active role in the visit allowed me to share the participant's identity as a leisure visitor, rather than being perceived as a distant observer (Haywood, 2018). This made my presence natural, helped me to get an insider perspective, and hopefully led to more natural experience for the participants.

The accompanied visits drew on the idea of structured observations (Thomas, 2017). The visitors' age and gender were recorded. I also noted down if they came alone (n=6) or in groups (n=4). A stopwatch was used to record the duration of interactions with each one of the nine exhibits if they chose to do that. The participants were regarded as interacting with an exhibit if they spend a minimum of 5 seconds paying attention to it, i.e. demonstrating any of the behaviours discussed below. This duration requirement is in line with the standard set by Sandifer (2003). If they ignored any of the nine exhibits, I did not draw their attention to it. I kept track of the behaviours that participants demonstrated when interacting with the nine exhibits mentioned above. Namely, I recorded if they (1) look at an exhibit, (2) start the activity, (3) finish the activity, (4) repeat the activity, (5) how many items they try in such exhibits as the Cups, the Choice, and the Smart Map; (6) observing the companion doing the activity; (7) talking to a companion about the activity during or right after the experience, (8) doing the activity together with a companion. Additionally, I took notes of situational variables, such as level of crowding, month, day of the week (Yalowitz & Bronnenkant, 2009).

Semi-structured interviews were conducted after the visit in order to get a detailed understanding of participants' experiences with exhibits. Interview questions covered issues of behavioural engagement, emotional and cognitive engagement, as well as personal, perceived social and physical contexts of the exhibition. Following the constructivist ideas, questions were formulated in the active voice, putting the participant as an active agent (e.g. "What did you enjoy?" instead of "What was enjoyable?"). A detailed list of questions is presented in Appendix 1.

4.2.2. Stage 2: Observations and short interviews

The second stage of the research included observing visitors in the museum during their interactions with the chosen nine exhibits and having short interviews with them afterwards. Since the sampling technique for accompanied visits has an obvious drawback of sample bias it was decided to increase the sample size by executing a second stage of the research.

4.2.2.1. Participants

At that stage, I was present at the exhibition for 5 days (both weekends and weekdays). I stood nearby one of the exhibits at a time and selected every first visitor or a group of visitors who approached the exhibits within my sight. Only adults who appeared to be 18-35 years old were included (n=19). The demographic data and social context for the participants at this stage are presented in Table 4.

Table 4.

Participant at Stage 2: Observations and short interviews.

	Pseudonym	Gender	Social context
1	Visitor 1	Female	Visit with a friend

2	Visitor 2	Female	Visit with a friend
3	Visitor 3a	Female	Visit together
4	Visitor 3b	Male	
5	Visitor 4a	Male	Visit together
6	Visitor 4b	Female	
7	Visitor 5a	Male	Visit together
8	Visitor 5b	Female	
9	Visitor 6a	Male	Visit together
10	Visitor 6b	Male	
11	Visitor 7	Female	Visit with a friend
12	Visitor 8	Female	Visit with companions
13	Visitor 9	Male	Visit with a friend
14	Visitor 10	Male	Visit with a friend
15	Visitor 11	Female	Visit with companions
16	Visitor 12	Male	Visit with a friend
17	Visitor 13	Female	Visit alone
18	Visitor 14a	Male	Visit together
19	Visitor 14b	Female	

4.2.2.2. Procedure

I observed and made notes about visitor's interactions with the digital exhibits and used a stopwatch to record the time of interaction. Unlike the first stage, I only observed each person interacting with 1-3 exhibits located close to one another, and not throughout the whole exhibition. I recorded the same data as at the first stage.

I waited until the visitor satisfied his/her interest about every exhibit in the nearby area and then approached him/her. I introduced myself, explained that I was doing a research for my master thesis, and asked for visitor's permission to ask several questions about their opinion regarding the exhibits. The questions are presented in Appendix 2. The short interviews were not recorded to avoid imposing additional tasks on visitors related to signing the informed consent forms. Instead, short notes were made during the interviews, and right after every interview I expanded them into detailed notes and quotes.

4.3. Analytic procedure

The recordings of interviews and accompanied visits were then fully transcribed. The resulting qualitative data (interview transcripts and field notes from observations) were analysed using coding and constant comparative method (Thomas, 2017). The utilized verbal data analysis software for coding and developing themes is MAXQDA2018. The steps (Thomas, 2017) included: (1) reading the data, (2) highlighting the important part and creating codes. Codes were both generated inductively based on the actual data and also informed by findings from the literature review. Then, (3) the data was read again, and codes were summarized into themes that were directly related to the research questions.

Regarding the first research question, the transcripts and observations were first coded based on the behaviours described in the original Visitor Engagement Framework by Barriault and Pearson (2010). Then I examined the generated codes for every particular exhibit and every particular visitor. It became clear that the existing VEF does not accommodate for all of the complexities of visitors' experiences at the Human Nature (HN) exhibition. These inconsistencies were coded and aggregated into several themes discussed in the Findings chapter. The quantitative data related to the holding times was analysed using descriptive statistics by calculating the median values for every exhibit. It was decided to prefer median over mean values due to the presence of outliers that might have considerably influenced the results.

In order to answer the second research question notes from the observations and interview transcriptions were coded using inductive coding but also informed by the factors identified in the literature review. The resulting codes were subdivided into those that describe the personal context, the social context, and the physical context in accordance with the Contextual Model of Learning. Then, tables with codes structured into the personal, social, and physical contexts as well as Initiation, Transition, and Breakthrough levels were created for all of the nine exhibits. The tables of codes for every exhibit are presented in Appendix 3. Further, these codes were united into the themes presented below.

4.4. Ethics

Informed consent forms were signed by participants of the accompanied visits. Following principles of competence, voluntarism, and full information (Cohen et al., 2002), participants were notified about the purpose of the research and what their participation would include, that their participation is voluntary and they can withdraw their agreement to participate at any moment. No risks were associated with participation. They were also asked for consent to audio-record the visits and after-visit interviews. To ensure confidentiality, the names used in this research are pseudonyms. Additionally, any personal details that may be used to identify a person were not included in the quotes used in this report.

At the second stage that included observations and short interviews with visitors, I used another common technique of implicit consent (Gutwill, 2002). I wore a badge with my name, and a sign with information about observations and interviews was placed at the entrance to the exhibition, so visitor observation was not unobtrusive.

5. Findings

This chapter presents the results of the study obtained via accompanied visits, observations, and interviews. The following research questions are addressed:

RQ1: Can Visitor Engagement Framework and/or the analysis of holding time be used to evaluate the engagement of adults with digital interactive exhibits in a museum?

The results demonstrate that the VEF may be used as a suitable framework for evaluating the engagement of visitors, however, the elaboration of the emotional dimension as well as re-evaluating the importance of repetition are required to reflect the complexity of visitors' experience (see section 5.1). Analysing holding times, on the other hand, does not allow to compare visitors' engagement levels across exhibits, but present other useful insights into the nature of visitor-exhibit interactions (see section 5.1.6).

RQ2: What personal, sociocultural or physical factors impact visitors' engagement levels?

It was observed that the level of visitors' engagement is influenced by the following factors: (1) factors of the physical context, i.e. visual attractiveness, length, ease-of-use and control, conceptual coherence and clear message of exhibits, passive or active nature of visitor-exhibit interactions; (2) factors of the personal context, i.e. previous knowledge and interests, and decision-making; (3) factors of the socio-cultural context, i.e. interactions within the social group, the need for privacy, and the perceived value of participation for the participant and for the museum (see section 5.2).

5.1. Evaluating engagement using the Visitor Engagement Framework and holding time analysis

In order to answer the first research question, the Visitor Engagement Framework (VEF) and the analysis of holding time were used as a basis for evaluating visitors' engagement. Since timing was criticized for not reflecting the quality of engagement (Falk et al., 2006), I started by applying the VEF, because it is grounded in the quality of visitor-exhibit relationships. After applying the original VEF to the data several inconsistencies were observed and aggregated into the following themes: (1) High cognitive engagement combined with negative evaluation of an exhibit; (2) Emotional engagement as the main outcome of interaction; (3) Repeating the activity does not always translate into higher engagement. Then, the adapted VEF is presented and applied to the data to create Visitor Engagement Profiles for the analysed exhibits. And finally, the analysis of holding times is presented.

5.1.1. High cognitive engagement combined with negative evaluation of an exhibit

The original VEF includes negative emotions exclusively at the Initiation stage, and these emotions are described in the literature as preventing visitors from reaching higher engagement levels (Barriault & Pearson, 2010). Meanwhile, the data demonstrates that sometimes critical attitude and dissatisfaction with an exhibit can accompany or even cause high cognitive engagement.

For instance, in the example below Emma shares her opinion about completing the survey in 'What Do You Think about Sustainable Consumption' exhibit. The exhibit reportedly prompted reflection and relating ideas from the exhibit to one's life, which are the aspects of the Breakthrough stage of engagement. Emma was overall satisfied with the content; however, she was disappointed about the lack of feedback from the exhibit.

Emma: I thought that was interesting, but I would have liked feedback. Again to see what others have answered... I didn't want to put in my email address. I know it's research, but I think they should give people something back.

Researcher: *Why was it interesting?*

Emma: *Just to reflect. Like the question, what would I borrow? Do I really need to own these things? I think I mentioned a car. It would be convenient if just 2 streets away there are cars that you can get if you want to go to IKEA. So it was good to reflect on things.*

In a similar way, several participants were also dissatisfied with the content of the Change exhibit, yet they still reached the Breakthrough level, as they made comparisons, deductions, and related the exhibit content to their own life and previous knowledge. However, unlike the previous example, Breakthrough level behaviours did not occur in spite of dissatisfaction, but resulted directly from the critical comments about the exhibit being perceived as unrealistic, trivial, or showing only one side of a story.

Victoria: *I don't like it, because one of the sentences was, like, to increase the work efforts in the countryside, we need to move to the countryside. But moving to the countryside would actually just mean creating new cities in the countryside. It's going round and round in circles, right?*

Emma: *Yeah, press the button, and everything was positive. I mean I was expecting something else and not just like yeah 'free time' and then it came up like if you work less then you earn less, and then you can buy less and you produce less. That was like trivial. But maybe I am already quite aware of what to do and what not, but it doesn't really give 'this is what you can do'. For example, 'try out to be vegan once per day, cause if you do that, you will reduce your carbon footprint that much per year'. It was all just positive. And regardless of what is going to happen, everything will be fine, because society does whatever the society can do, which I don't think is true. So this one sounded a bit too positive. Because the other day I just read that in 2040 there will be no polar caps. In 20 years! Probably we can't even stop it. Scary.*

These examples from the data demonstrate that negative evaluation of an exhibit does not always prevent visitors from moving to higher levels of engagement. It can also exist at the Transition and Breakthrough levels as a drawback tolerated by visitors or even function as an incentive of engagement.

5.1.2. Emotional engagement as the main outcome of the interaction

The second contradiction is also connected with emotional engagement. The original framework includes such aspects as being interested in or displeased with the activity at the Initiation level and demonstrating the enjoyment of the outcome at the Transition level. However, the description of the Breakthrough level does not contain any references to positive or negative emotional reactions. In contrast, the data demonstrates that affective aspects, such as feeling hopeful or sad, empathizing, etc., may also be a part of high-level engagement along with the cognitive aspects.

Interestingly, while inspiring hope in visitors is one of the main messages according to the exhibition description (Human Nature. About the exhibition, n.d.), only one of the participants explicitly mentioned feeling hopeful as a result of interaction with the 'What Do You Think about Sustainable Consumption' exhibit. In this example feeling hope was a result of the high level of cognitive engagement demonstrated through making deductions regarding the content of an exhibit. So emotional engagement may not only facilitate cognitive one but result from it as well.

Visitor 10: *It actually made me feel hopeful. Usually we hear bad things about the environment, and this made me hopeful that there is something that we can do.*

Empathy was another important affective outcome of interactions with exhibits, especially those that involved the narrative aspect. For example, the Cups exhibit that contains stories of cups' owners prompted empathy along with reflection about one's life:

Visitor 2: *We listened to all of them but one. I liked it because I could feel the feelings they were talking about. It made me think about something that we buy and get attached to it. But it may not turn out to be this way for always. Like it is said: love that has cooled down.*

Likewise, the Dark Room exhibit also promoted emotional engagement, but only in one of the participants who interacted with it.

Emma: *I really like this one. I think it was really nice to evoke a feeling in your body. For me it was quite strong and I felt like a lot of sadness. I mean in a way that's good that they have 'worry - be happy' as like not everything is bad. They try to find something positive. And then at first I thought that the pictures that they had, these moving things on the wall are just random pictures. But then it's the ones that were back in the beginning. So when you look at them, you can see the ones that carry, for example, all these bags full of trash. So they are connected to consumption. And now I also get this part. They should have had it in the beginning, because it evokes feelings. And maybe I would have looked at things in a different way.*

Emma was the only participant who noticed that moving images on the screen mirrored the videos of environmental problems demonstrated earlier in the exhibition, such as people carrying big packs of garbage, which is also a type of visual narrative. Therefore, she could make the connection between the audio that she was listening to and the overall theme of the exhibition, which may have led to the deep emotional engagement of feeling sadness and empathy.

5.1.3. Repeating the activity does not always translate into higher engagement

Another type of contradiction was found in relation to the importance of repetition. Repetition may be a sign of engagement in science centres, where visitors can use the exhibits multiple times to achieve different results or try different strategies. However, most of the digital exhibits in the Human Nature exhibition do not imply hypothesis testing and focus more on gathering and communicating information in different modalities. Thus, repetition does not happen for the same reasons as in science centres, and the lack of repetition does not automatically mean low engagement. For example, both Visitor 3 and Visitor 2 listened to several stories in the Cups exhibit, but Visitor 3 only wanted to understand how the content is connected to the overall theme of sustainability, while Visitor 2 genuinely enjoyed the narratives and proceeded to the high levels of engagement.

Visitor 3: *I expected it to be more clear after the 2nd one, but it didn't, so I didn't want to press another one.*

Visitor 2: *We listened to all of them but one. I liked it because I could feel the feelings they were talking about. It made me think about something that we buy and get attached to it.*

Similarly, Emma did the activity in the Robot exhibit twice, because she was confused if the robot was talking about an object or a person, and wanted to listen again to the beginning of the robot's speech.

Emma: *I did it twice because first I thought that it was about a thing, but it was about a relationship. So I wanted to try it out if it makes more sense.*

Hence, according to the data, there are two main reasons for the repetition to occur: (1) a visitor does not understand the message of the exhibit and repeat the activity in an attempt to figure it out; (2) a visitor enjoys the content and wants to obtain additional information.

5.1.4. The resulting adapted Visitor Engagement Framework

After inconsistencies between the original VEF and the obtained data were discovered, the framework was adapted to suit the needs of the present research. Aspects of emotional engagement were added to the Transition and Breakthrough levels, and repeating the activity at higher levels was substituted by completing the activity at least once. In addition, several minor changes were also introduced based on the observations. For example, while the initial framework states that calling someone over to look at

an exhibit can only occur at the Breakthrough level, it was decided to move this aspect to the Initiation level, because the data from this research demonstrates that several participants called their companions to look at the robot exhibit even if they were not willing to complete the activity at all, merely because the exhibit was reportedly “weird” or “creepy”. For a better overview of the aspects at every level, it was decided to structure them according to the facets of engagement: behavioural, emotional, and cognitive one. The categories for the updated VEF are presented in Table 5.

Table 5.

Visitor Engagement Framework adapted for the Human Nature exhibition

	Behavioural engagement	Emotional engagement	Cognitive engagement
Initiation level	<ul style="list-style-type: none"> • Not completing the activity • Doing the activity completely • Watching another person doing the activity • <i>Doing the activity together with a companion</i> • <i>Call somebody to look at the exhibit</i> 	<ul style="list-style-type: none"> • Expressing interest in the activity • Displeased with the exhibit (<i>dissatisfied, not interested, confused</i>) 	
Transition level	<ul style="list-style-type: none"> • <i>Completing the activity at least once or more</i> • <i>Trying several items within one activity</i> • Having short discussions • <i>Trying to look for more information</i> 	<ul style="list-style-type: none"> • Expressing enjoyment about the experience • <i>Expressing negative emotions, disappointment, confusion</i> 	<ul style="list-style-type: none"> • Making general comments about the <i>technology or the content</i> • <i>Simple references to one’s life</i>
Breakthrough level	<ul style="list-style-type: none"> • <i>Completing the activity at least once or more</i> • <i>Trying several items within one activity</i> • Discussing the activity and results • Seeking and sharing information 	<ul style="list-style-type: none"> • <i>Positive emotional reaction to the result of the activity</i> • <i>Negative emotions intended by the exhibit</i> • <i>Empathy</i> • <i>Dissatisfaction</i> 	<ul style="list-style-type: none"> • <i>Critical reflection</i> • <i>Conceptual change</i> • Relating new ideas to current knowledge • Referencing to past experiences, one’s life, and making comparisons and deductions

Note. The suggested amendments are presented in italics.

5.1.5. Visitor Engagement Profile (VEP)

Barriault and Pearson (2010) suggest that recording the levels of engagement is followed by creating a Visitor Engagement Profile of an exhibit in order to analyse visitor-exhibit interaction. Each of the levels is represented by a bar showing the number of visitors who demonstrated the behaviours related to a certain level. It only includes those visitors who stop and pay attention to the exhibit (Initiation

behaviour is always 100%). Following their advice, VEPs were created for every analysed exhibit (Figure 11).

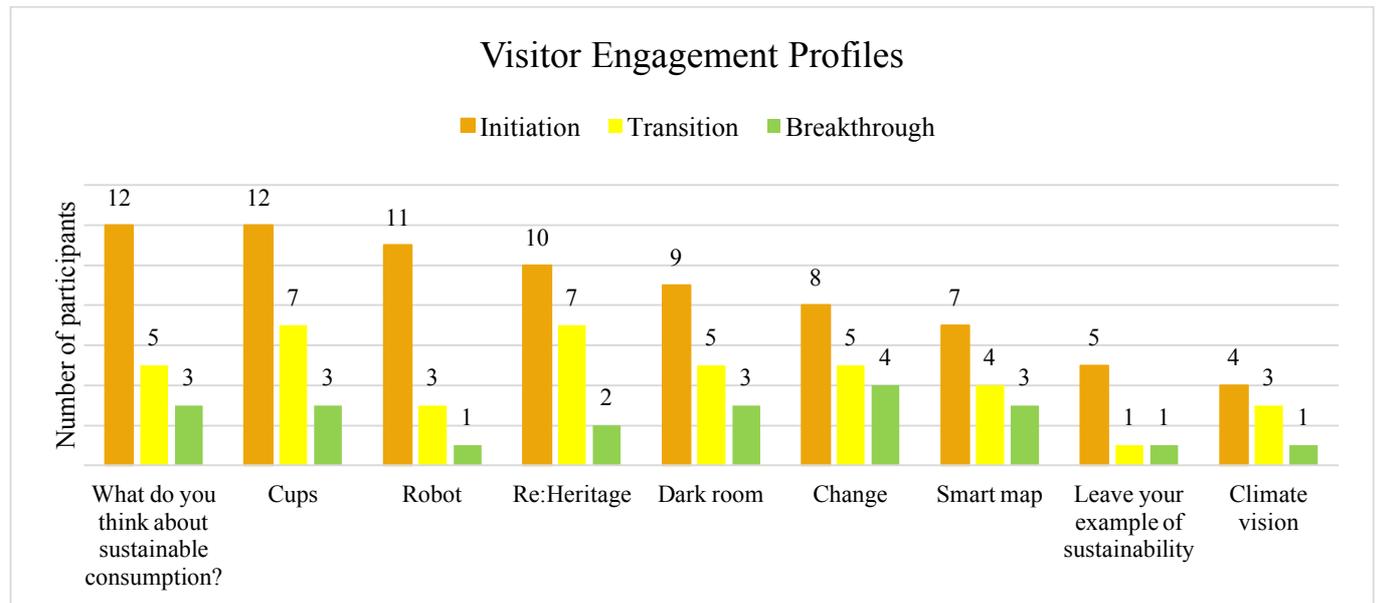


Figure 11. Visitor engagement profiles for the analysed exhibits.

Based on the chart we may conclude that the Robot exhibit was the least ‘successful’ one (Barriault & Pearson, 2010) because it has the largest gap between the Initiation and higher levels. The Re:Heritage, the Change, and the Smart Map exhibits demonstrate the best conversion from Initiation to Transition to Breakthrough level. However, it is important to remember, that these charts must be interpreted with caution because of the small sample. For example, while the Climate Vision exhibit may seem as a ‘successful’ one because there is only one person who disengaged at the Initiation level, there are only four participants overall.

5.1.6. Comparing the analysis of holding times and the Visitor Engagement Framework

It was discussed in the literature review that timing has been a widely-used method in visitor studies for almost a century (Yalowitz and Bronnenkant, 2009). One of the most important variables is holding time, i.e. the duration of interaction with a specific exhibit. Longer holding times are associated with higher engagement. Thus, analysis of holding times was considered by some researchers as a method to evaluate the successfulness of exhibits (Eghbal-Azar et al., 2016; Myrczik, 2014). In a similar way, the authors of the original VEF considered time as an indicator of Breakthrough behaviour level (2 min, 3-5 min, more than 5 min) (Barriault & Pearson, 2010). However, the validity of this method was questioned because holding time does not necessarily tell us about the quality of this experience (Falk et al., 2006).

In order to analyse the validity of using holding time as a measure of engagement, the holding time for every participant and every exhibit was recorded. Then, based on the adapted VEF participants were divided into categories: Initiation (participants who disengaged at this level), Transition (participants who disengaged at this level), and Breakthrough. Within each group the medians of the holding times were calculated. The resulting values are visualised using the line chart (Figure 12).

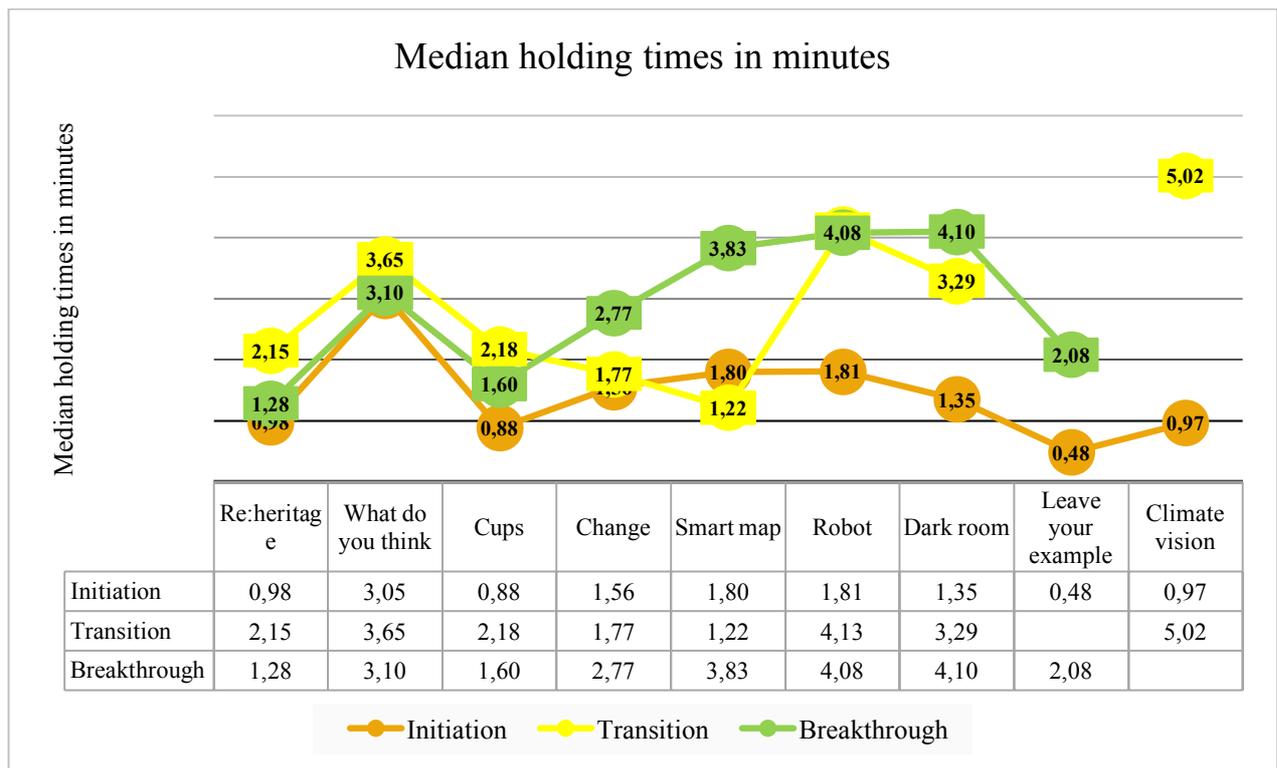


Figure 12. Median holding times for the analysed exhibits.

Several conclusions can be made based on this chart. First of all, it is often the case in the data that the higher the engagement level – the more time participants spent interacting with the exhibit. However, this is only valid in the context of every individual exhibit, and cannot be used to compare exhibits. For instance, the median for the Initiation level for the Robot exhibit is higher than the median holding time for the Re:Heritage exhibits at the Breakthrough level. It can even be assumed judging by this chart that the Robot is one of the most successful exhibits because the medians are relatively high compared to other exhibits. However, while the Re:Heritage exhibit is a three-question and easy-to-use survey, it took some time for participants to even start the activity at the Robot exhibit. So comparing holding time among exhibits can mainly shed light on how long the activities are designed to be. Therefore, I have excluded time durations from the adapted VEF, as these values do not take into account the intended durations of activities.

However, this chart may elicit discussions about why holding time is very similar across different levels of engagement in one group of exhibits (e.g. the Re:Heritage and the ‘What Do You Think about Sustainable Consumption’ exhibits), while in a different group there is a considerable variation among levels (e.g. the Smart Map, the Dark Room). It implies that in the first group of exhibits participants tended to finish the activity even though they may not have been very engaged with it. The reasons for that may include physical characteristics of an exhibit, such as shortness of the activity or ease-of-use, as well as social ones, such as willingness to help the researchers by completing the survey (it will be discussed in more details in section 5.2).

Given the discussed points, analysing holding times is not a suitable method of evaluating engagement in the context of this particular study, however, it does provide valuable insights into different patterns of visitor-exhibit interactions and thus can serve as an inspiration for further investigations.

5.2. Personal, sociocultural or physical factors influencing visitors' engagement level

The focus of the second research question laid on the factors influencing visitors' engagement with the digital interactive exhibits. The following themes were developed during the analysis of field notes and interview transcripts and grouped according to the Contextual Model of Learning.

5.2.1. Physical context

5.2.1.1. **Visual attractiveness, length, and ease-of-use – important but not enough for high engagement**

Such physical characteristics of digital exhibits as visual attractiveness, control, and length of the activity were widely discussed by participants as playing a big role in their engagement. Visual attractiveness includes such aspects as appealing graphics (i.e. cartoon-like drawing of the Change exhibit), explicit interactivity of an exhibit (e.g. it is obvious that the buttons next to the cups in the Cups exhibit can be pressed), and perceived novelty of the technology (e.g. the Robot exhibit). Ease-of-use refer to whether it is intuitively clear how to manipulate the exhibit.

The observations and interviews revealed that such visual attractiveness characteristics as physical interactivity and digital character of the Re:Heritage exhibit attracted attention and promoted visitors to engage with it at an Initiation level, e.g. “*Hey, it's touch screen*” (Liam). However, while nine out of ten participants who interacted with the Re:Heritage exhibit finished the survey, only two of them reached the Breakthrough level. The participants explained that they finished the survey despite the lack of interest because it looked visually attractive, easy-to-use, and short enough, so it did not require too much effort to complete.

Anna: And it looked fun and easy. If it was like fifteen questions at the first one, then maybe I wouldn't have finished it. But there are just one or two questions...

At the same time, visual appeal was not always perceived as a positive aspect. For example, while the big screen and the cartoon-like character of the Change exhibit were reported to attract the initial attention, it also created higher expectations about the content, that were not always satisfied.

Liam: It was underwhelming. I expected more from it. I came in and I saw all these big buttons and a big screen. And instead what I get is I am pressing one, and it's like ok, you like clean water.

As for the ease-of-use, whether or not an exhibit was intuitively understandable considerably influenced participants' engagement level. For example, interacting with the Robot exhibit was challenging for many participants. The instructions for using the exhibit state: “Select your language. Type your answer when the light is on and press enter.” However, in order to see them, a user needs to turn one's head away from the robot and the keyboard. So, it took time for some participants to understand how to activate the exhibit. Even after participants read the instructions, they often forgot that they needed to type, and tried to answer the robot's questions out loud. This confusion may be explained from the perspective of personal context. Participants previously interacted with robots or virtual assistants using voice commands, so they expected the same mode of communication. Another confusing aspect was that there were long pauses between the robot's lines, so participants thought that they were expected to answer something.

Oscar: But both you and me thought that we should type in more stuff because it has the long pauses as if it expects you to answer.

The discussed characteristics of visual attractiveness and ease-of-use refer mainly to the design issues of the technology itself rather than the actual content. Thus, while these features played a big role in attracting visitors' attention and facilitating the interaction with an exhibit, their mere presence did not

immediately translate to high engagement, and could even cause dissatisfaction if the actual content did not meet participants' expectations.

5.2.1.2. Lack of control leading to frustration

The lack of control caused by the design issues of exhibits was often referred to as a reason for disengagement. While it is similar to the ease-of-use concept, the difference is that it may be intuitively clear how to use the exhibit, but still hard to control it. For example, participants who interacted with the Cups exhibit often wanted to switch to another cup while the previous narrative was not finished yet. It is very clear how to switch to another cup, however, an exhibit is designed in such a way every audio is played till the end. Therefore, participants were not willing to wait and listen to something that they did not find valuable enough.

Liam: They were interesting, but I felt like I wanted to switch because it took so long in explaining the background.

As for the Smart Map exhibit, participants, who disengaged at the Initiation level, frequently expressed frustration about their interaction with the exhibit. They said that it was hard to manipulate, because they clicked on the screen and then had to wait for several seconds to get a response, and it was not obvious how to use the map function of the exhibit. Besides, when going anywhere beyond the scope of the Smart map website, e.g. clicking on the Facebook link for one of the projects, it was not possible to go back to the Smart map website. So, it was no longer possible to use the exhibit at all.

Liam: How do I go back?! Did I break this? Why does it keep reloading? Wait, no... Why would you do this? I'm gonna make this work. But I don't have any controls. There is no Alt key. Ok, I can't deal with that.

Therefore, the lack of control over the exhibit and one's experience caused by intentional design decisions or drawbacks of technology was perceived as a substantial hindrance for engagement.

5.2.1.3. Unclear messages and lack of conceptual coherence as constraints of engagement

Another common reason mentioned by the participants who disengaged after the Initiation level was the lack of conceptual coherence and failure to comprehend the message of the exhibit.

The unclear message of the exhibits was discussed by the participants regarding the Smart Map and the Climate Vision exhibits. It mainly took place at the beginning of an interaction, and if a user independently or with the help of others moved beyond this initial confusion, then he/she could reach higher levels of engagement. This initial confusion was supposedly caused by the fact that the goal of the activity was not clearly presented on the very first screen, so when approaching the exhibit visitors had to spend some time playing around with it. However, both exhibits were explicitly about the environmental issues (i.e. sustainability-related initiatives and carbon dioxide emission). So once it became clear, participants easily connected the content with the overall theme of the exhibition:

Grace: I don't understand what it is. Ah, ok, that was the point.

In contrast, the participants, who interacted with the Cups, the Dark Room, and the Robot exhibits, often lost interest not because they could not understand the messages of the exhibits, but rather because they failed to make this connection between the content of exhibits and the exhibition theme. The Cups and the Robot exhibits are focused on the idea of the relationships that people have with things that they own. The connection between this topic and the overall theme of sustainability is implied because a number of other exhibits are devoted to excessive consumption, however, it is not explicitly described. As a result, several participants listened to one or more cups but could not relate the narratives told by the cups' owners to the sustainability issues.

Grace: *You need to show me in the museum, why you put that one there. Why is it relevant to what we were talking before, to this thing with the environment?*

Similarly, many participants reported that they did not understand the message that the Robot exhibit was trying to communicate, because the sign at the entrance asks the visitor to think about an object that a visitor considers replacing, then the robot says “There is something that you are considering replacing...”, but the further narrative of the robot made the users think that it was talking about personal relationships. Therefore, participants were confused if the whole activity was about an object or about a person that they wanted to ‘replace’. Some of them disengaged before finishing the activity, while others stayed until the end or even repeated the activity hoping that they would eventually understand the concept.

Visitor 5: *I didn't get the point, I typed in 'guitar' but then the robot was talking about relationships that are more personal. I stayed because I expected it to become clearer by the end.*

Emma: *I did it twice because first I thought that it was about a thing, but it was about relationships. So I wanted to try it out if it makes more sense. [...] And in a way I thought it was about sustainability, so it felt really weird that it was about relationship all of a sudden.*

Therefore, both the unclear message of an exhibit and the lack of conceptual coherence caused difficulties in proceeding to higher levels of engagement. However, while the confusion caused by unclear message was sometimes resolved via social interactions or by a more careful examination of the exhibit, the failure to connect the message of an exhibit with the overall theme of sustainability became a more substantial obstacle for engagement.

5.2.1.4. Passive nature of an exhibit as a reason to disengage

While seven out of nine exhibits analysed in the present study have relatively strong physical interactive components, meaning that every action that a participant took was almost immediately followed by some kind of feedback, the Robot and the Dark Room exhibits were more dialogically interactive. The activities are mainly passive, as visitors sit and listen to audio recordings, and, in the case of the robot, they only type two words. The interactivity in these cases is caused by the fact that users are personally addressed: the robot asks a user to think about his/her possession, and in the Dark Room visitors are addressed using ‘you’ pronoun and are asked to relax, think, reflect. Some participants commented that they were not willing to sit and listen to something, they preferred more active types of interaction. Interestingly, when referring to their decision to leave the exhibit before the activity ended, participants commonly talked about their personal preferences rather than the perceived drawback of the exhibits: “*I guess I was not in the mood for sitting down*” (Visitor 7), or “*It's not my kind of content [...] I just can't wait*” (Grace).

5.2.2. Personal context

5.2.2.1. Previous knowledge determining the level of engagement

The match between participants’ previous knowledge and the information presented by the exhibits proved to play a vital role in determining the level of engagement. The lack of new information hindered moving to the Breakthrough level with its substantial comparative and analytical reflections. Nevertheless, a participant may still feel positive about the exhibit:

Visitor 13 (about ‘What Do You Think about Sustainable Consumption’ exhibit): *It's great, it's important. But I already do a lot of things that are suggested here.*

On the contrary, participants for whom the information was reportedly new tended to be more engaged. For instance, those, who interacted with the Change exhibit, commented that while some aspects were familiar to them, still the exhibit presented new perspectives and encouraged them to think outside the box:

Anna: *I think it was stuff that I already knew. But they had different aspects of it that wouldn't be the first things that come to mind. Like if we earn less, we don't have that much money to spend. Or if we build more playgrounds and parks, then we don't have to drive everywhere. Like kind of different aspects that I, of course, knew about, but maybe it was not the first thing to like come to mind.*

5.2.2.2. Appealing to personal background and interests as a way to engage visitors

The exhibits that directly appeal to users' personal experiences are the Re:Heritage that asks visitors questions about an object that they own, the Cups exhibit that covers a familiar experience of owning and using every-day objects, and the Smart Map that offers geographically relevant and applicable information about different sustainability initiatives in the city where the museum is located. This personal relevance brought up the transition to higher levels of engagement, as participants naturally established connections to their lives. For instance, users of the Cups exhibit, which can be considered as one of the 'successful' exhibits based on its VEP, reflected about their attitude towards owning different objects:

Visitor 5: *It made me think about things that I own, like this jacket, it's 10 years old because it's of good quality. I could have chosen my phone, but we change it every 2 years.*

Appealing to personal background was also connected with an exhibit being valuable for participants. So if participants were previously interested in activities related to sustainable consumption, they saw the Smart Map exhibit as a valuable source of new ideas that may be applicable in their daily lives. In fact, when asked if they learnt something new at the exhibition and if they found something relevant to their lives, all of the three participants who reached the Breakthrough level with this exhibit mentioned the Smart Map in their answers to both questions.

Elena: *Ah, that is cool. Oscar, there are groups on Facebook for changing plants. Ah, to work at somebody else's place at home. That's cool. That is super cool. I also want to work like that. I want to see where it is. There is no hoffice in Gothenburg.*

Researcher: *Is there anything that you found relevant to your life?* Emma: *Yes, again, I can say the Smart Map, even though I couldn't really do things here now, but I would certainly look at it at home.*

Visitors' interests and preferences had a major influence on the level of engagement with an exhibit. For example, the 'What Do You Think about Sustainable Consumption' exhibit was mentioned by Anna as the one from which she had learnt the most, and it was actually her initial interest in leading a more sustainable life that encouraged her to interact with the exhibit:

Anna: *Yes. I find this topic... like how can you change your habits. I thought that was interesting. I want to become more aware. I think [that it was useful]. I think the questions were good, interesting. Yeah, like good questions that made me think.*

It may be concluded, that appealing to visitors' personal background by offering something they can use in their lives, and/or inviting them to think about something relevant (e.g. objects that they own) may instigate higher levels of engagement. At the same time, even though the discussed exhibits attempt to address visitors' background, it was often the participants' prior interests in the topic of an exhibit that determined the resulting level of engagement.

5.2.2.3. Disengagement as strategic decision-making

The conscious decision not to continue interaction with a particular exhibit was explicitly mentioned by two of the participants at the accompanied visits stage. The reasons for making this decision included the assessment of the potential value of the activity. For example, Oscar was looking for the exhibits that were relevant to him personally, therefore he was not interested in listening to other people's stories about their relationships with cups:

Oscar: *I like the idea that you has some stuff that have some sentimental value for you. But then to hear about other people's sentimental value for me is not so interesting. Other stuff was more interesting in this exhibition because they were really concerning me.*

Besides, the repetition and lack of new information also led to the decision to disengage and devote time to something more valuable:

Elena: *And then I stopped because one story was repeating. Like the cup ended up in the back of a cupboard and then I heard that again. And then I moved on.*

The discussed extracts from the data demonstrate the agency that some participants took over their experience in order to avoid museum fatigue and have a more pleasurable and valuable visit.

5.2.3. Sociocultural context

5.2.3.1. Influence of companions on the experience of interaction with exhibits

The interactions within social groups (i.e. among visitors who come to the exhibition together) was observed as having an influence on participants' decisions and level of engagement with specific exhibits. For instance, Oscar was not interested in finishing the Robot activity, however, he decided to still do that due to the presence of his companion:

Oscar: *No, the robot was also not... I don't know... There was so many other stuff at the exhibition that more concerning me.*

Researcher: *But why have you stayed till the end then?*

Oscar: *Well... Elena came in...*

Another type of influence was also recorded within the same dyad of participants. Elena tried interacting with the Climate Vision exhibit but decided that it was too complex. Then, Oscar, her companion, tried it and initiated a discussion about the content, which made Elena more engaged. So in the interview after the visit she actually mentioned this exhibit among those which contributed to her learning.

Elena: *It was too complex. After Oscar did it, I understood, but I wouldn't have had the patience to play around.*

Elena: *[...] and maybe when you were playing with this vision thing. It was a good visualisation of what an individual can actually do.*

According to the data, the influence of social interactions with companions may be very different. On the behavioral level, it encouraged some participants to stay and finish the activity. From the cognitive engagement perspective, it also helped some participants to understand the message of exhibits and subsequently move to higher levels of engagement.

5.2.3.2. Privacy as an aspect of social context influencing engagement

The concept of privacy was discussed by several of the participants. It was mentioned that the presence of other visitors nearby could make the participants' experience less pleasant and discourage them from continuing the activity. For example, the prompt for the Change exhibit asks a visitor to choose the aspect that is important for him/her. Hence, the participant did not feel comfortable to make her choice public:

Visitor 13: *It was good, but... I tried one, but it felt really personal, because it is said to choose what is important for me, and it was so loud as if I am showing it to everybody. It would be better to have it on the small screen. If it was more private, I would look at other aspects as well.*

Emma also noted that her experience of the Dark Room exhibit depended on the social context and was only possible if not many people were around in the exhibition.

Emma: To be honest it's also quite quiet today. I don't think I would have spent so much time because it feels really personal. And when they said that you should allow your feelings, so I don't think, that I would have done it or would have felt the same and spent that much time if there were more people.

Additionally, two participants at the accompanied visits stage mentioned that they felt the pressure from other visitors as they used exhibits, and would prefer to use their own devices, e.g. smartphones:

Adam: Also if you use the screen, you feel the pressure from other people, who are there, and they are probably waiting for you to finish.

5.2.3.3. Participatory exhibits: what is the value of participation?

The participatory exhibits refer to those that empower visitors to act as active participants and contribute to the museum. The examples of such exhibits in the Human Nature exhibits include (1) Re:Heritage, that invites visitors to participate in a research project; their answers to the survey are then counted in the statistics shown to other visitors; (2) 'What Do You Think about Sustainable Consumption', which is another research project that collects visitors' opinions but does not offer any statistics; and (3) 'Leave Your Own Examples of Sustainability' which is the most explicitly participatory exhibit among those studies here. It invites visitors to make suggestions about sustainable life choice, and those suggestions are immediately shown on the main screen of the exhibit. While the participatory nature of exhibits is a part of the physical context, I found it suitable to include the analysis of relevant data in the socio-cultural context section, because participants actually discussed social interactions and transfer of knowledge from visitors to the museum, from the museum to visitors, and from visitors to other visitors. It was the value of this communication, that was influencing the level of visitor's engagement with exhibits.

First, being nice to researchers who had created surveys was reported as one of the reasons to finish the activity, even while these participants were not really interested in the content, or were already knowledgeable about the topic:

Anna: Because I am trying to be nice to the ones who are doing the exhibition I think. And it looked fun and easy. If it would be like 15 questions at first one, then maybe I wouldn't have finished it.

Second, participants found it important to know if the results of the research in which they participated would be used by someone to make a change for the better. For example, Oscar reported that he saw no value in contributing to the 'Leave Your Own Examples of Sustainability' exhibit:

Oscar: Yeah I didn't do. It's a good idea. But I have to think about it more to make something more fruitful. I wasn't sure of what they would use it for. Would it be like a database and they would go through it or will it be used for research? Because later on there was this research, then I wanted to engage. It would be useful. But with that one, I wasn't sure what it would be used for.

Emma also did not see that visitors might come up with some new and valuable suggestion:

Emma: Because I feel that there are so many people talking about like solutions. And there are so many solutions out there that have been thought about. And the suggestions, the ten ones that we saw were like.... 'Don't exploit natural resources'. That's like yeah, of course, I know that.

On the other hand, if a participant saw the value of his/her contribution, then he/she was more likely to move to the Breakthrough level of engagement:

Elena: I like sharing ideas and coming up with ideas. But I would like to see the others, so then I stopped. Because you can't see others... You only see what you give in.

In addition to the value of one's contribution, participants were also concerned about receiving feedback as a result of their participation. The themes of expectations and feedback are discussed at every level of engagement with the survey type of exhibits. Most participants expected that after they completed the surveys, they would get some results. Regarding the Re:Heritage exhibit, out of six people who moved to the Transition and Breakthrough levels four discovered the page with statistics, while none of those four who stayed at the Initiation phase did. Participants who did not discover the statistics and got disengaged after the Initiation stage felt dissatisfied and frustrated that they had invested their time in the survey, but did not get anything in return:

James: Yeah. I don't know, like if someone asks me something, a bunch of questions about one specific thing, I expect some kind of result.

Those participants who actually found the statistics were more likely to enjoy their experience and demonstrate Breakthrough behaviours, such as making comparisons and deductions. For example, Emma considered this exhibit as one of the most enjoyable ones:

Emma: I was surprised that so many people clicked books, I thought that was interesting. I thought there would be no one else, but there were so many who clicked books. Cool, yeah.

Similarly, the expectations and feedback ideas were prominent in discussions about the second survey: 'What Do You Think about Sustainable Consumption'. However, unlike the previous exhibit, that contained statistics, this survey does not provide any feedback.

Grace: I was doing it because I thought maybe it was something interesting at the end. Not actually because the questions were interesting. I thought that something was going to happen. You know for example a piece of information... Like in Sweden... people and consumerism.

So, visitors who took part in this study and engaged with participatory exhibits found it vital to see the value of their participation both for the creators of these exhibits, and for themselves, e.g. by getting feedback. The perceived lack of this value not only discouraged them from moving to higher levels of engagement but also caused disappointment and frustration.

In summary, the results of the present research demonstrate that the Visitor Engagement Framework may be used for evaluating engagement with digital interactive exhibits in the context of the Human Nature exhibition. However, several adjustments regarding emotional engagement and the importance of repetition need to be included to reflect the particularities of visitors' experiences. As for the holding time, it may provide interesting insights into visitor-exhibit interactions, but cannot be used independently to assess and compare engagement levels across several exhibits. Regarding the second research question, the data uncovered that while visual attractiveness, ease-of-use, physical interactivity, and control over interaction are important for initiating visitors' engagement, it was vital for participants to understand the message of an exhibit and how this message fits into the overall theme of the exhibition. Moreover, if an exhibit appealed to participants' interest, background, and every-day life, yet offered new information, visitors were more likely to engage with this exhibit at higher levels. As some of the exhibits invited visitors to contribute to the research, participants were concerned about the value of this contribution for themselves and for the museum. Finally, the data shows that interactions with companions sometimes enhanced participants' experience, while the simultaneous presence of other people in the exhibition was perceived by some participants as causing discomfort and inhibiting engagement.

6. Discussion

6.1. Adapting the Visitor Engagement Framework for the Human Nature exhibition

This research attempted to apply the Visitor Engagement Framework to evaluate visitors' engagement with digital interactive exhibits. The results demonstrate that the VEF proves to be a useful instrument in assessing visitors' engagement. However, it cannot explain all the peculiarities of engagement occurring in the World Culture Museum, probably because it was designed for science centres. Adapting the framework for the Human Nature exhibition mainly moved along the two axes: emotional engagement and repetition.

6.1.1. Elaborating emotional engagement

Museums are places for emotional experience (Del Chiappa, et al., 2014; Munro, 2014). However, the emotional engagement is only briefly discussed in the literature on engagement on museums. It is generally assumed that positive emotions (e.g. enjoyment, excitement, hope) support engagement, while negative ones (e.g. boredom, anxiety, sadness) constrain it. For example, it is supposed in the original VEF that visitors may experience negative emotions at the Initiation stage and disengage after it, or that they experience positive emotions during the Transition stage and stay focused on the activity (Barriault & Pearson, 2010; Shaby et al., 2017). However, the present research demonstrates that negative emotions are diversely present in the engagement experience. First, negative emotions can be the desired outcomes of the exhibit, e.g. feeling sadness because of the images of pollution and consumption in the Dark Room exhibit, or empathy and sadness while listening to stories of the 'cooled down' love at the Cups exhibit. Surprisingly, while Shaby et al. (2017), already noted that negative emotions do not always mean that the exhibit is 'unsuccessful' and may be essential for understanding the message, they did not add this conclusion to their version of the VEF. Therefore, experiencing negative emotions intended by the exhibition was added to the VEF based on this research.

Secondly, the high level of cognitive engagement was found to exist despite dissatisfaction and critical attitude towards the exhibit. Similar to Kim et al. (2018), the research shows that if a person is initially interested in the topic covered by the exhibit, he/she is more likely to tolerate some unmet expectations (e.g. not receiving feedback).

Thirdly, dissatisfaction was found to cause engagement manifested through reflective and analytical processes. While it was not discussed in the reviewed literature on engagement in museums, some potential explanations may be found in the research on the impact of emotions on learning and achievement in formal education. Pekrun (1992) argues that a positive mood may foster creative thinking, while negative mood may enhance analytical thinking. This, of course, would work differently for *activating negative emotions* (e.g. anxiety, shame, anger) that motivate a person to cope with the situation and *deactivating emotions* (e.g., boredom, hopelessness), which can inhibit this motivation (Pekrun, Goetz, Titz, & Perry, 2002). The dissatisfaction observed in this research may refer to the activating negative emotion that instigated critical and analytical thinking among participants. However, more research is needed to examine the connections between emotions and engagement in museums.

6.1.2. Excluding repetition

Repetition was excluded from the requirements for the Transition and Breakthrough levels, mainly due to the differences between science centres and the Museum of World Culture. According to the data, repetition may signify almost opposing situations. Visitors may enjoy the activity and try out different items of this activity, or a visitor may not understand the message of the exhibit, and repeat to have more time to understand it. Thus, repetition without the detailed notes on how and why it happened may not serve as an indicator of engagement.

6.2. Holding time as an unsuitable measure of evaluating engagement

In line with the conclusions by Falk et al. (2006), recording the duration of visitor-exhibit interactions proved to be an unsuitable method for evaluating engagement across different exhibits, because it did not take the intended durations of activities into account. However, visualising median holding times for participants at different levels of engagement according to VEF provides an interesting overview of exhibit characteristics. For example, it may demonstrate the visitors tend to finish an exhibit activity regardless of their level of engagement or give insight into the exact moment in activity when visitors usually lose interest.

6.3. Factors of the physical, personal, and sociocultural contexts that influence visitors' engagement levels

6.3.1. Physical context

From the physical context perspective, visual attractiveness, ease-of-use, interactivity, and conceptual coherence were found to be the main factors influencing engagement.

First, visual attractiveness was observed to attract attention and facilitate interaction. It confirms the previous research that posits that visual appeal of information motivates a visitor to approach an exhibit (Hinrichs, Schmidt, & Carpendale, 2008). However, the mere presence of these aspects did not immediately translate to high engagement, as a visitor can finish an activity without reaching Transition or Breakthrough stages if the content does not meet his/her expectations or if the message of an exhibit is not clear. Tomita (2018) also argues that the motivation to engage in an activity depends mainly on whether the content is personally interesting, while the visual design can only arouse initial curiosity. It is also important to note, that visual elements including the perceived novelty of technology, can create high expectations, and if they are not met, then these elements can even be considered as shortcomings of the exhibit.

Secondly, intuitive understanding of how to operate an exhibit and the exhibit being responsive to these manipulations also impact visitors' engagement. The most prominent example from the data is the Robot exhibit, which was manipulated via a keyboard. Nevertheless, the majority of the participants tried to speak to it despite the sign with instructions. Hinrichs et al. (2008) note that interactions with digital exhibits should be as intuitive as possible. From the personal background perspective, it may be assumed that some people nowadays are used to operating virtual assistants on their phones and laptops using voice control, therefore they tend to do the same with the Robot exhibit.

Thirdly, while the presence of physical interactivity attracted visitors' attention, it did not always lead to high engagement, which depended more on the content of the exhibit and visitors' personal interest. This dependence on personal interest was even stronger for the dialogically interactive exhibits, as participants often were not willing to 'sit and wait'.

Finally, the lack of conceptual coherence and failure to understand the message of the exhibit were the major reasons for disengagement at the Initiation level, which mirrors the discussions by Allen (2004) and Goulding (2000). Sheng and Chen (2012) also argue that one of the most prominent expectations that visitors have is for a museum to be fun and easy. Following the same line of thought, several participants in this study mentioned that they expected a museum to provide clear connections between exhibits and the main theme so that it is easy to follow. However, the negative impact of an unclear message and lack of conceptual coherence can be mitigated by discussions with companions, having a personal interest in or prior knowledge about the content.

6.3.2. Personal context

From the perspective of the visitors' personal context, it was found that previous knowledge about the exhibit content and relevance to visitors' lives played an important role in determining the level of engagement. It generally corresponds to the reviewed literature and reflects the active role of a visitor advocated in the constructivist approach towards meaning-making in a museum (Adams, 2006; Insulander and Selander, 2009).

Similar to the conclusions by Skydsgaard et al. (2016), participants were less likely to move to the Breakthrough level if the exhibits did not contain information that was new for them, while the presence of new facts led to higher cognitive engagement and conceptual change. However, as it was mentioned in the section on elaborating emotional engagement, the lack of conceptual change does not always mean low cognitive engagement, as critical thinking can also be a part of the Breakthrough stage.

Furthermore, as argued by Insulander and Selander (2009) and Kim et al. (2018), visitors' interests and preferences have a major influence on the level of engagement with an exhibit. If a visitor is initially interested, he/she is more willing to tolerate perceived the drawbacks of design.

Lastly, exhibits that appealed to visitors' personal background tended to be successful in terms of high engagement outcomes that they provoked. The reviewed literature covers such approaches of appealing to visitors' background as using personal narratives (Skydsgaard et al.) and familiar activities, such as riding a bicycle (Shaby et al., 2017). The present research also demonstrates that other potential ways of encouraging visitors to make connections with their personal lives are by inviting them to reflect about something that is personally meaningful for them (e.g. the Re:Heritage exhibit) or by explicitly offering some practical information that they can actually take away and use (e.g. the Smart Map exhibit). Making an exhibit relevant addresses one of the most common dissatisfactions that visitors have about museums not being connected with their lives (Simon, 2010).

6.3.3. Sociocultural context

The analysis of the factors from the sociocultural context highlighted the importance of personal interactions between visitors within a social group, as well as the impact of other people present in the exhibition on a visitor's experience, and the social side of participatory exhibits.

Shaby et al. (2017) argue that exhibits supporting social interactions promote engagement. It is, in fact, the case, that though discussions are possible at the Initiation level of engagement, they were much more present at higher levels (see Appendix 3). Social interactions with companions also supported the engagement with an exhibit, as companions can potentially explain the unclear messages (Insulander & Selander, 2009).

An interesting finding that was not reflected in the analysed literature is related to the concept of privacy. While some researchers claim that museums are highly social environment and supporting the collaborative exploration of an exhibit is a way to support engagement (Hinrichs et al., 2008), the research data demonstrates that presence of other visitors nearby could actually make the participants' experience less pleasant and discourage them from continuing the activity. The reasons included: the activity being perceived as too personal to share with others, feeling the pressure of other people waiting for their turn to use the exhibit, and being insecure about the quality of one's contribution and how it will be perceived by other visitors. These observations correspond with findings by Goulding, (2000) who argue that some visitors also seek solitude in museums, and by Kim et al. (2018) who found that crowding is one of the main reasons of museum fatigue. Scott, Hinton-Smith, Härmä, and Broome (2013) also note that museums with a focus on interactivity, visibility, and participation are oriented towards extraverted visitors, who are willing to take risks; and this attitude makes the experience less pleasurable for those who do not want to participate in the same way. The researchers note, that this shyness is actually a very wide-spread phenomenon among participants.

Since three of the nine analysed exhibits invite visitors to share their opinion and contribute to the museum, it is no surprise that the interaction between visitors and the museum was also perceived as vital for participants' engagement. Simon (2010) wrote that a participatory project should create new value both for the museum and for participants. Visitors who took part in the present research considered it highly important to see how their contributions would be used and if they would contribute to a project making a difference. If they saw this value, they were more likely to move to the Breakthrough level of engagement. As a matter of fact, 'being nice' to researchers who created the exhibits was a common reason to finish the activity despite the lack of interest. Another concern that participants had is also in line with Simon's (2010) discussion: visitors need to see that their contributions bring in something new. This was the problem with the 'Leave Your Own Examples of Sustainability' exhibit. Participants did not see that they could come up with something that researchers had not thought about before. In addition to the value for the museum, participants were also concerned about receiving feedback from the exhibits. Again, in accordance with Simon's (2010) reasoning, fulfilling one's need is critical for the satisfaction with an exhibit. Those participants, who actually found the feedback in the form of statistics, were more likely to enjoy their experience and demonstrate Breakthrough behaviours, such as making comparisons and deductions.

6.4. Limitations of the study

The limitations of the present work are primarily related to the chosen research frame of a case-study (Cohen et al., 2002). First, the limitation of accompanied visits, observations, and interviews is connected with the researcher bias, meaning the "projection of researcher's own values and judgements onto the situation" (Cohen et al., 2002, p. 240). It is addressed by using inductive coding and paying particular attention to outlying cases. Second, the mere presence of a researcher may have had an influence on the participants. It has been shown that visitors who are asked to view the exhibits (i.e. cued visitors) tend to be more attentive than non-cued visitors (Grack Nelson & Cohn, 2015; Serrell, 2000). To mitigate this limitation, I chose to recruit participants for accompanied visits in advance and establish some contacts with them beforehand, so that they feel more comfortable during the accompanied visit. I also explicitly explained that I was not involved in designing the exhibition. However, this approach brings up the bias in recruiting participants, which was partially addressed by applying the methodological triangulation and including the second stage of research.

Another related limitation is the experimenter expectancy effect, that implies that phrasing of question or tone of researcher's voice may influence participants' answers, as they would be prone to answer in a way that they think is expected of them (Thomas, 2017). Therefore, I made an effort not verbalize any personal judgements about the exhibition during the accompanied visits or interviews. Additionally, using interviews means relying on self-reported answers, and it has been noted that visitors do not always know why they did this or that action, or are not willing to share (Thomas, 2017).

Regarding the analysis and conclusions drawn, the limitation of the study is also connected with fact, that it lacks the investigator triangulation, that would increase the reliability of the study (Cohen et al., 2002). It is especially important when applying the Visitor Engagement Framework to the specific cases of engagement with exhibits, because there are several occasions on which the distinction between levels is not very clear, and it is the judgement of a researcher that determines the decision. For instance, the VEF amended by Shaby et al. (2017) include "Asking questions regarding the operation of the exhibit or the outcome" at the Transition level, and "Ask them to explain an exhibit; asking a question to staff or family member without lengthy discussion or exploration of topic" at the Breakthrough level.

As for the generalisation, it is not indented that the results of the present case study can be statistically generalized, because the sample of the case study only represents itself rather than a population (Cohen et al., 2002). However, this research aims at logical generalizability, which refers to the ability

of the case study to contribute to wider theory and help other researchers understand similar cases (Cohen et al., 2002).

Additionally, although the present study did attempt to cover the complexity of visitors' experiences in a museum, there are still some aspects that are missing but are potentially capable of influencing engagement with exhibits, e.g. space set-up of the museum, lighting and sound, etc. Also, the interaction of visitors with other digital and non-digital exhibits in the Human Nature exhibition was not analysed, while it may, in fact, influence greatly visitors' experience. For example, they may be tired from reading long text labels and thus become less engaged in further digital interactive exhibits.

Finally, although I analyse holding times using descriptive statistics, it is important to recognize limitations related to the small sample size. Therefore, additional research on comparing timing and the Visitor Engagement Framework with a larger sample is required to verify the conclusions made in this research.

7. Conclusion and Implications

This research was conducted to understand how engagement with digital interactive exhibits can be evaluated in museums other than a science centre on the example of the Museum of World Culture and which aspects may impact the level of engagement with these exhibits. Two research questions were posed to address this purpose.

RQ1: Can the Visitor Engagement Framework and/or analysis of holding time be used to evaluate the engagement of adults with digital interactive exhibits in a museum?

For this research question the results demonstrate that the VEF, created for science centres, can also be used to assess visitors' engagement in museums other than science centres, but some adaptations are required. The study has uncovered the need to elaborate the emotional dimension at the Initiation, Transition, and Breakthrough levels of engagement and re-evaluate the role of repeating the exhibit activity.

First, regarding the emotional engagement, in contrast to the original VEF experiencing negative emotions such as sadness may be the desired outcome of the exhibits and thus happen rightfully at any level. Secondly, negative emotions, e.g. frustration with technology, can accompany but not prevent high engagement, especially if a user has prior interest in the content of an exhibit or a topic of an exhibition. Thirdly, dissatisfaction with the exhibit may provoke analytical thinking and thus become a source of high engagement. Including negative emotions in the discussion of engagement in museums would allow researchers to obtain a more detailed and rich understanding of visitors' experience in various types of exhibitions and museums. Undoubtedly, additional research on emotional engagement is required. For example, in addition to exploring the effect of emotions on here-and-now engagement in an exhibition, it is also vital to track long-term effects of negative or positive emotions on visitor's learning in terms of knowledge retention, and changes in values and attitudes both towards the topic of the exhibition and towards visiting this or other museums in general. Additionally, this conclusion of the present research also presents an interest for the evaluation of exhibitions by museum professionals. On the one hand, even though the engagement with an exhibit may be evaluated as high, it does not always imply that the exhibit has been perceived as 'successful' by these particular visitors. On the other hand, in line with the constructivist thinking, it is the visitor who constructs one's understanding of an exhibit, and experiencing dissatisfaction may be a rightful way to process the content.

Furthermore, while repetition may be a sign of high engagement in science museums, it proved to be very context-specific and may be the consequence of either enjoyment or confusion. Therefore, it is suggested to substitute repetition at Transition and Breakthrough levels of engagement with 'doing the activity at least once', as repetition without the detailed notes on how and why it happened may not serve as an indicator of engagement.

As for the holding time, according to the research results, it does not allow to compare visitors' engagement levels across exhibits, or provide accurate information about 'successfulness' of an exhibit, and therefore may be excluded from the VEF. Meanwhile, the study suggests that in the future researchers and practitioners may use it together with other instruments to present useful insights into the nature of visitor-exhibit interactions, e.g. patterns in finishing the exhibit activity. Having said that, the present research has a limited sample, and additional studies on comparing the VEF and analysis of holding times may reveal other conclusions.

RQ2: What personal, sociocultural or physical factors impact visitors' engagement levels?

It was observed that the level of visitors' engagement is influenced by a number of factors from the physical, personal, and sociocultural context. Aspects of the *physical context* that have the largest

impact on engagement include such aspects of exhibit design as visual attractiveness, ease-of-use, conceptual coherence of exhibits, and passive or active nature of visitor-exhibit interactions. To begin with, visual attractiveness including the perceived novelty of technology was observed to attract attention and facilitate interaction. However, this attractiveness does not guarantee high levels of engagement and satisfaction with the exhibit. Visual elements can inspire curiosity and create high expectations. If they are not met, then these visual elements can even be considered as drawbacks of the exhibit. Similarly, while physically interactive exhibits are more successful in encouraging visitors to finish the activity compared to dialogically interactive one, ultimately, it is the content of an exhibit and visitors' interest that determine the level of engagement. It is not a new discovery, yet it once again supports the view, that digital technology is only reasonable and valuable in a museum when it can provide a meaningful experience for visitors. Furthermore, the perceived ease-of-use and clear connection between the exhibit content and the exhibition theme proved to be essential for visitors' engagement. The shortcomings in these areas may lead to visitors' disengagement despite the initial interest in the overall topic. Therefore, it is vital for the museum professionals to test their solutions thoroughly, and also to analyse similar technologies that people use in their everyday life in order to understand if visitors would intuitively comprehend how to control the exhibits. Besides, it may be beneficial to test not only the intuitiveness of usage, but also the overall perception of connectedness among the contents of different exhibits.

From the perspective of the visitors' *personal context*, it was found that previous knowledge about content, personal interest, and relevance of exhibits to visitors' lives played an important role in determining the level of engagement. Similar to the previous research, this study argues that encountering new information and interacting with exhibits that suit visitor's interests may contribute to engagement and even mitigate dissatisfaction with some perceived downsides of exhibits. The present research also demonstrates that exhibits which invite visitors to reflect on something tangible and meaningful for them, as well as exhibits offering some practical and applicable information are particularly good in supporting visitors' engagement.

The analysis of factors from the *sociocultural context* highlighted the importance of interpersonal interactions between visitors within a social group, as well as the impact of other people present in the exhibition on a visitor's experience, and the perceived value of interacting with participatory exhibits for visitors and for the museum. The research has demonstrated the role of privacy for the visitors' engagement with exhibits. The activity may be perceived as too personal to share with others; visitors may feel the pressure of other people waiting for their turn to use the exhibit or be insecure about the quality of their contribution. While there are some previous studies that covered the 'shyness' of visitors in museums, they are far less in number than the studies that promote the social nature of exhibits. Therefore, future research on visitors' need for privacy and solitude is needed to create a balanced view of the issue. In addition, it may be beneficial for museums to take into consideration the needs of both visitors seeking social experience and those seeking privacy.

Finally, the interaction between visitors and the museum within the context of participatory exhibits was also perceived as vital for participants' engagement. The results are in line with Simon's (2010) argument that a participatory project should create new value both for the museum and for participants. Accordingly, visitors' engagement depends on whether they can see the value of their contribution, and how their contribution will be used. Thus, it is the obligation of a museum to provide clear, honest, and sufficient information about the project that they invite visitors to participate in. Furthermore, visitors find it important to see that their contributions bring in some new value that museum professionals or researchers would not be able to obtain otherwise. It should be taken into considerations by the museums when designing an exhibit. And finally, fulfilling visitors' need for feedback is critical for museums in supporting visitors' engagement and establishing mutually beneficial relationships with its visitors.

Reference list

- Adams, P. (2006). Exploring social constructivism: Theories and practicalities. *Education*, 34(3), 243-257.
- Allen, S. (2004). Designs for learning: Studying science museum exhibits that do more than entertain. *Science education*, 88(S1), S17-S33.
- Archer, L., Dawson, E., Seakins, A., & Wong, B. (2016). Disorientating, fun or meaningful? Disadvantaged families' experiences of a science museum visit. *Cultural Studies of Science Education*, 11(4), 917-939.
- Ashley, S. L. (2014). 'Engage the World': examining conflicts of engagement in public museums. *International Journal of Cultural Policy*, 20(3), 261-280.
- Azevedo, R. (2015). Defining and measuring engagement and learning in science: Conceptual, theoretical, methodological, and analytical issues. *Educational Psychologist*, 50(1), 84-94.
- Bailey-Ross, C., Gray, S., Ashby, J., Terras, M., Hudson-Smith, A., & Warwick, C. (2016). Engaging the museum space: Mobilizing visitor engagement with digital content creation. *Digital Scholarship in the Humanities*, 32(4), 689-708.
- Barriault, C., & Pearson, D. (2010). Assessing exhibits for learning in science centres: A practical tool. *Visitor Studies*, 13(1), 90-106.
- Barron, P., & Leask, A. (2017). Visitor engagement at museums: Generation Y and 'Lates' events at the National Museum of Scotland. *Museum Management and Curatorship*, 32(5), 473-490.
- Bitgood, S. (2009a). Museum fatigue: A critical review. *Visitor Studies*, 12(2), 93-111.
- Bitgood, S. (2009b). When is "museum fatigue" not fatigue? *Curator: The Museum Journal*, 52(2), 193-202.
- Boekaerts, M. (2016). Engagement as an inherent aspect of the learning process. *Learning and Instruction*, 43, 76-83.
- Briseño-Garzón, A., Anderson, D., & Anderson, A. (2007). Adult learning experiences from an aquarium visit: The role of social interactions in family groups. *Curator: The Museum Journal*, 50(3), 299-318.
- Cohen, L., Manion, L., & Morrison, K. (2002). *Research methods in education*. Routledge.
- Chang, K. E., Chang, C. T., Hou, H. T., Sung, Y. T., Chao, H. L., & Lee, C. M. (2014). Development and behavioral pattern analysis of a mobile guide system with augmented reality for painting appreciation instruction in an art museum. *Computers & Education*, 71, 185-197.

- Csikszentmihalyi, M., & Hermanson, K. (1995). What makes visitors want to learn? Intrinsic motivation in museums. *Museum News*, 74(3), 34-37.
- Damala, A., Hornecker, E., van der Vaart, M., van Dijk, D., & Ruthven, I. (2016). The loupe: tangible augmented reality for learning to look at ancient Greek art. *Mediterranean Archaeology and Archaeometry*, 16(5), 73-85.
- Davey, G. (2005). What is museum fatigue. *Visitor Studies Today*, 8(3), 17-21.
- Del Chiappa, G., Andreu, L., & G. Gallarza, M. (2014). Emotions and visitors' satisfaction at a museum. *International Journal of Culture, Tourism and Hospitality Research*, 8(4), 420-431.
- Dindler, C., & Iversen, O. S. (2009, August). Motivation in the museum-mediating between everyday engagement and cultural heritage. In *The Nordes Conference, Oslo*.
- Dindler, C., Iversen, O. S., & Krogh, P. G. (2011). Engagement through mixed modalities. *interactions*, 18(4), 34-39.
- Doolittle, P. E., & Hicks, D. (2003). Constructivism as a theoretical foundation for the use of technology in social studies. *Theory & Research in Social Education*, 31(1), 72-104.
- Eghbal-Azar, K., Merkt, M., Bahnmüller, J., & Schwan, S. (2016). Use of digital guides in museum galleries: Determinants of information selection. *Computers in Human Behavior*, 57, 133-142.
- Everett, M., & Barrett, M. S. (2009). Investigating sustained visitor/museum relationships: Employing narrative research in the field of museum visitor studies. *Visitor Studies*, 12(1), 2-15.
- Gutwill, J. P. (2002). Gaining visitor consent for research: Testing the posted-sign method. *Curator: The Museum Journal*, 45(3), 232-238.
- Falk, J. H. (2011). Contextualizing Falk's identity-related visitor motivation model. *Visitor Studies*, 14(2), 141-157.
- Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: Alta Mira Press.
- Falk, J. H., Dierking, L. D., & Adams, M. (2006). Living in a learning society: Museums and free-choice learning. *A companion to museum studies*, 323-339.
- Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of educational research*, 74(1), 59-109.
- Fredricks, J. A., Wang, M. T., Linn, J. S., Hofkens, T. L., Sung, H., Parr, A., & Allerton, J. (2016). Using qualitative methods to develop a survey measure of math and science engagement. *Learning and Instruction*, 43, 5-15.
- Goulding, C. (2000). The museum environment and the visitor experience. *European Journal of marketing*, 34(3/4), 261-278.

- Grack Nelson, A., & Cohn, S. (2015). Data collection methods for evaluating museum programs and exhibitions. *Journal of Museum Education*, 40(1), 27-36.
- Harvey, M. L., Loomis, R. J., Bell, P. A., & Marino, M. (1998). The influence of museum exhibit design on immersion and psychological flow. *Environment and Behavior*, 30(5), 601-627.
- Hein, G. E. (1998). *Learning in the museum*. London: Routledge.
- Hein, G. E. (2006). Museum education. *A companion to museum studies*, 340-352.
- Hinrichs, U., Schmidt, H., & Carpendale, S. (2008). EMDialog: Bringing information visualization into the museum. *IEEE transactions on visualization and computer graphics*, 14(6), 1181-1188.
- Hillman, T., Weilenmann, A., Jungselius, B., & Lindell, T. L. (2016). Traces of engagement: narrative-making practices with smartphones on a museum field trip. *Learning, Media and Technology*, 41(2), 351-370.
- Holdgaard, N., & Simonsen, C. E. (2011). Attitudes towards and conceptions of digital technologies and media in Danish museums. *MedieKultur: Journal of media and communication research*, 27(50), 19-p.
- Hooper-Greenhill, E. (2006). Studying visitors. *A companion to museum studies*, 362-376.
- Human Nature. About the exhibition. (n.d.). Retrieved from <http://www.varldskulturmuseerna.se/en/varldskulturmuseet/ongoing-exhibitions/human-nature/about-the-exhibition/> [accessed: 15.05.2019]
- Insulander, E., & Selander, S. (2009). Designs for learning in museum contexts. *Designs for Learning*, 2(2), 8-20.
- Jewitt, C. (2012). Digital technologies in museums: New routes to engagement and participation'. *Designs for Learning*, 5(1-2).
- Kim, M., Dillon, J., & Song, J. (2018). The Factors and Features of Museum Fatigue in Science Centres Felt by Korean Students. *Research in Science Education*, 1-18.
- Kylie Budge & Alli Burness (2018) Museum objects and Instagram: agency and communication in digital engagement, *Continuum*. Literature review.
- Lanir, J., Kuflik, T., Sheidin, J., Yavin, N., Leiderman, K., & Segal, M. (2017). Visualizing museum visitors' behavior: Where do they go and what do they do there?. *Personal and Ubiquitous Computing*, 21(2), 313-326.
- Meecham, P., & Stylianou, E. (2012). Interactive technologies in the art museum. *Designs for Learning*, 5(1-2), 94-129.
- Munro, E. (2014). Doing emotion work in museums: reconceptualising the role of community engagement practitioners. *Museum and Society*, 12(1), 44-60.

- Myrczik, E. P. (2014). Satisfying personal needs at the museum: The role of digital technologies. *MedieKultur: Journal of media and communication research*, 30(57), 21-p.
- Nakamura, J., & Csikszentmihalyi, M. (2014). The concept of flow. In *Flow and the foundations of positive psychology* (pp. 239-263). Springer, Dordrecht.
- Haywood, N. (2018). Accompanied Visits as a Tool to Understand Visitors' Experiences: A Critical Reflection and Proposed Typology. *Visitor Studies*, 21(1), 135-147.
- National Museums of World Culture (n.d.). Retrieved from <http://www.varldskulturmuseerna.se/en/the-government/the-national-museum-of-world-cultures/> [accessed: 15.05.2019]
- Norman, D. A. (2013). Design of everyday things: Revised and expanded. *Hachette, New York*.
- O'Brien, H. L., & Toms, E. G. (2008). What is user engagement? A conceptual framework for defining user engagement with technology. *Journal of the American society for Information Science and Technology*, 59(6), 938-955.
- Olesen, A. R. (2016). For the sake of technology? The role of technology views in funding and designing digital museum communication. *Museum Management and Curatorship*, 31(3), 283-298.
- Packer, J., & Ballantyne, R. (2016). Conceptualizing the visitor experience: A review of literature and development of a multifaceted model. *Visitor Studies*, 19(2), 128-143.
- Pallud, J. (2017). Impact of interactive technologies on stimulating learning experiences in a museum. *Information & Management*, 54(4), 465-478
- Pecore, J. L., Kirchgessner, M. L., Demetrikopoulos, M. K., Carruth, L. L., & Frantz, K. J. (2017). Formal lessons improve informal educational experiences: The influence of prior knowledge on student engagement. *Visitor Studies*, 20(1), 89-104.
- Pekrun, R. (1992). The impact of emotions on learning and achievement: Towards a theory of cognitive/motivational mediators. *Applied Psychology*, 41(4), 359-376.
- Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational psychologist*, 37(2), 91-105.
- Rounds, J. (2004). Strategies for the curiosity-drive museum visitor. *Curator: The Museum Journal*, 47, 389-412.
- Sandifer, C. (2003). Technological novelty and open-endedness: Two characteristics of interactive exhibits that contribute to the holding of visitor attention in a science museum. *Journal of research in science teaching*, 40(2), 121-137.

- Schreiber, J. B., Pekarik, A. J., Hanemann, N., Doering, Z., & Lee, A. J. (2013). Understanding visitor engagement and behaviors. *The Journal of Educational Research*, 106(6), 462-468.
- Schwan, S., Grajal, A., & Lewalter, D. (2014). Understanding and engagement in places of science experience: Science museums, science centers, zoos, and aquariums. *Educational Psychologist*, 49(2), 70-85.
- Scott, S., Hinton-Smith, T., Härmä, V., & Broome, K. (2013). Goffman in the gallery: Interactive art and visitor shyness. *Symbolic Interaction*, 36(4), 417-438.
- Serrell B (1997) Paying attention: the duration and allocation of visitors' time in museum exhibitions. *Curator: The Museum Journal* 40(2): 108–125
- Serrell, B. (2000). Does cueing visitors significantly increase the amount of time they spend in a museum exhibition. *Visitor Studies Today*, 3(2), 3-6.
- Shaby, N., Assaraf, O. B. Z., & Tal, T. (2017). The Particular Aspects of Science Museum Exhibits That Encourage Students' Engagement. *Journal of Science Education and Technology*, 26(3), 253-268.
- Simon, N. (2010). *The participatory museum*. Museum 2.0.
- Skydsgaard, M. A., Møller Andersen, H., & King, H. (2016). Designing museum exhibits that facilitate visitor reflection and discussion. *Museum Management and Curatorship*, 31(1), 48-68.
- Thomas, G. (2017). *How to do your research project: A guide for students*. Sage.
- Tomita, K. (2018). Does the Visual Appeal of Instructional Media Affect Learners' Motivation Toward Learning?. *TechTrends*, 62(1), 103-112.
- Witcomb, A. (2006). Interactivity: thinking beyond. *A companion to museum studies*, 39, 353-61.
- Yalowitz, S. S., & Bronnenkant, K. (2009). Timing and tracking: Unlocking visitor behavior. *Visitor Studies*, 12(1), 47-64.
- Zimmerman, H. T., Reeve, S., & Bell, P. (2010). Family sense-making practices in science center conversations. *Science Education*, 94(3), 478-505.

Appendix 1. Interview questions at stage 1: Accompanied visits

The list of questions used during the interviews at the first stage of research (after accompanied visits) is presented here, in Appendix 1. The questions are subdivided into several sections in accordance with the questions topics.

Stage 1. Interview questions	
Personal context: background questions	<p>Is it your first time at this exhibition?</p> <p>Have you ever been to this museum?</p> <p>Can you think of a museum visit from the past that you really enjoyed and why?</p>
<p>Questions about each of the nine exhibits</p> <p>The choice of questions depended on the actual behaviour of the participant</p>	<p>What do you think about [name of the exhibit]?</p> <p>Did you enjoy it? What did you enjoy? What did not you like?</p> <p>You have not finished the activity. Why?</p> <p>You repeated the activity. Why?</p> <p>You tried [number of items, e.g. listened to two cups]. Why did you decide to try another item? Why did you decide to stop?</p> <p>You did not enjoy the activity, but still finished it. Why?</p>
Questions on emotional engagement	<p>Which exhibit did you enjoy the most?</p> <p>Which exhibit did you enjoy the least?</p> <p>Did you wish for the visit to be over sooner?</p>
Questions on cognitive engagement	<p>Do you think you have learned something new? What?</p> <p>Was there something relevant for you and your life?</p> <p>Is there any take-away message that you have from this exhibition?</p>

Appendix 2. Interview questions at stage 2: Observations and short interviews

The list of questions used during the interviews at the second stage of research is presented here, in Appendix 2.

Stage 2. Interview questions	
<p>Questions about each of the nine exhibits</p> <p>The choice of questions depended on the actual behaviour of the participant</p>	<p>What do you think about [name of the exhibit]?</p> <p>Did you enjoy it? What did you enjoy? What did not you like?</p> <p>You have not finished the activity. Why?</p> <p>You repeated the activity. Why?</p> <p>You tried [number of items, e.g. listened to two cups]. Why did you decide to try another item? Why did you decide to stop?</p> <p>You did not enjoy the activity, but still finished it. Why?</p>

Appendix 3. Tables of classified codes for individual exhibits.

The codes generated for every exhibit are presented in tables below. The Visitor Engagement Profile (VEP) row indicates the number of participants who engaged with the exhibit at a specific level (Initiation, Transition, Breakthrough). Only people who engaged with an exhibit at the Initiation level are included, therefore the number of people in the VEP for Initiation level is 100% of all of the participants who interacted with the exhibit. Furthermore, the codes are subdivided into the factors from physical, sociocultural and personal contexts. And finally the lists of codes related to the Visitor Engagement Framework (VEF) are presented in the last rows of every table. The numbers in round brackets indicate the number of participants who demonstrated or talked about the specific issues (e.g. at the Initiation level for the Re:Heritage exhibit two participants mentioned the lack of feedback).

Re:Heritage

	Initiation	Transition	Breakthrough
VEP	10	7	2
Physical context	Short (neutral; positive) Screen as attraction Appealing visual Lack of feedback (2) Easy to use No value of contribution Lack of control (choose several items)	Short (negative) Screen as attraction (2) Presence of feedback Interactive Lack of control Too many actions to take Lack of feedback (2) Presence of feedback	Short (negative) New information Not easy to use Presence of feedback
Socio-cultural context	Interested in other people's opinions (missing) Be nice to authors	Discussion (3) Interested in other people's opinions (4)	Discussion Interested in other people's opinions
Personal context	Expectations (2) Memories	Memories (3) Curious Not interested Personal preferences and interests Distant	Memories Expectations Previous museum visits Curious Personal preferences and interests Relevant Memories
Related to VEF	Dissatisfied (2) Not interested Confused Doing the activity completely Watching another person doing the activity	Reflection (2) It was ok (2) Unsatisfied Not interested Interested Discussions (3) Making general comments Simple references to life	Positive emotions (2) Interested Reflection (2) Conceptual change Discussion Referencing to past experiences and making comparisons

What Do You Think about Sustainable Consumption?

	Initiation	Transition	Breakthrough
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VEP	12	5	3
Physical context	Enjoy multiple choice questions Short (positive) Lack of feedback (3)	Easy to use Perfect amount of content No new info	Value of contribution New info (2) Lack of feedback
Socio-cultural context	Be nice to authors Interested in other people's opinions (missing)	Discussions Be nice to authors	Discussion Interested in other people's opinions
Personal context	Personal preferences and interests Previous knowledge (2) Relevant Expectations (3)	Relevant (2) Previous knowledge	Relevant (3) Personal preferences and interests Curious Expectations
Related to VEF	Positive emotions Neutral (3) Dissatisfied (3) Not interested Doing the activity completely	Positive emotions (2) Reflection Discussion Trying to look for more information Simple references to one's life	Interested (2) Reflection (2) Positive emotion (2) Conceptual change (3) Dissatisfied

Cups

	Initiation	Transition	Breakthrough
VEP	12	7	3
Physical context	Narrative Lack of control Too much content Lack of coherence (4)	Interactive Attraction power Lack of control (2) Narrative (2) Too long Repetition Narrative Authenticity Too slow	Narrative (2) Not easy to use Attraction power Unusual/unexpected (2) Lack of coherence Lack of control Tangible Understandable objects Rather form than content
Socio-cultural context		Discussion (2) Concerned about companion's experience	Discussion (2) Other people present
Personal context	Expectations Not willing to wait	Not willing to wait (2) Personal preferences and interests (2) Curious Make a choice Memories Distant	Expectation Curious Relevant (2) Memories
Related to VEF	Confused (4) Positive emotions Dissatisfied Not interested (2) Interested Not completing the activity	Interested (2) Dissatisfied (2) Reflection Positive emotions (2) Not interested Trying several items Having short discussions	Interested (2) Sadness/depression Positive emotions (3) Empathy Referencing to one's life and interests (2) Confused

	Doing the activity completely Watching another person doing the activity	Making general comments	Trying several items
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Change

	Initiation	Transition	Breakthrough
VEP	8	5	4
Physical context	Too slow Appealing visual Lack of control No new info Personal / Private	Too slow Lack of feedback Appealing visual	Too slow New info (2) Rather form than content Appealing visual (2) No new information Unrealistic content (2) New information Easy to use
Socio-cultural context	Distracted		Discussion (3)
Personal context	Not willing to wait Personal preferences and interests	Relevant Expectations Previous knowledge	Relevant (4) Previous knowledge (4) Personal preferences and interests (2) Expectations
Related to VEF	Bored Not interested Dissatisfied (2) Positive emotions I would stay longer Doing the activity completely Doing the activity together with a companion	Dissatisfied Reflection Trying several items Doing the activity together with a companion Interested	Interested (3) Conceptual change (2) Dissatisfied (2) Reflection (3) Criticism (2) Positive emotions (2) Trying several items Relating new ideas to current knowledge

Smart Map

	Initiation	Transition	Breakthrough
VEP	7	4	3
Physical context	Not easy to use (2) Unclear message Too slow Interactive Lack of control Crashed / not working New info	No new information	Not easy to use Crashed / not working New info (3)
Socio-cultural context			Discussion (3)
Personal context	Relevant Curious Not willing to wait	Relevant (about Gothenburg or Sweden) Previous knowledge	Relevant (about Sweden or Gothenburg) (3) Personal preferences and interests (3)

			Previous knowledge Curious
Related to VEF	Access outside museum Unsatisfied (3) Not interested Not completing the activity	Positive emotions Access outside museum Not interested Doing the activity completely Trying several items Trying to look for more information	Positive emotions (3) Interested (3) Access outside museum (3) Reflection Seeking and sharing information Discussion (3) Relating new ideas to current knowledge

Robot

	Initiation	Transition	Breakthrough
VEP	11	3	1
Physical context	"Weird / scary (3) Not easy to use (4) Unclear message (4) Lack of control (2) Rather form than the content Repetition (lack of interactivity) Interactive Attraction power Authenticity Coherence Unusual / unexpected	Weird / scary Not easy to use Unclear message Too slow Lack of control Rather form than content (2) Charm of new technology	Charm of new technology Not easy to use Weird / scary Lack of control Clear message
Socio-cultural context	Influence the decision of companions Discussion Want to show to the companion	Influence the decision of companions	Influence the decision of companions Concerned about companion's experience
Personal context	Make a choice Distant Expectations (2) Not willing to wait Curious	Previous knowledge	Try oneself Memories
Related to VEF	Interested (3) Dissatisfied Reflection Confused (3) Not interested (2) Not completing the activity Doing the activity completely Repeating the activity Call somebody to look at the exhibit	Reflection (2) Confused Doing the activity completely Dissatisfied	Interested Reflection Doing the activity completely Referencing to past experiences

Dark Room

	Initiation	Transition	Breakthrough
VEP	9	5	3
Physical context	Slow (2) Coherence (2) Lack of control Voice (2)	Unusual / unexpected Too blunt	Not easy to use Voice (positive) Clear message Personal / privacy Unusual / unexpected
Socio-cultural context	Influence the decision of companions		Influence the decision of companions Other people present
Personal context	Personal preferences and interests (2) Not willing to wait (2) Relevant		Relevant (3)
Related to VEF	Not interested (3) Sadness / depression Relaxation Confused Dissatisfied Positive emotions Relaxation Not completing the activity Doing the activity completely	Interested Dissatisfied Reflection Positive emotions Doing the activity completely	Positive emotions (3) Relaxation (2) Interested Compassion / sadness / anger as intended Reflection (2) Doing the activity completely

Leave Your Own Examples of Sustainability

	Initiation	Transition	Breakthrough
VEP	5	1	1
Physical context	No new information No value of contribution Trivial		Feedback Value of contribution
Socio-cultural context	About other people's answers (2) Sharing ideas		Sharing ideas About other people's answers
Personal context	Personal preferences and interests Previous knowledge		Curious Personal preferences and interests Previous knowledge
Related to VEF	Misinterpret Dissatisfied Anxious or stressed Watching another person doing the activity		Positive emotions Doing the activity completely Trying several items

Climate Vision

	Initiation	Transition	Breakthrough
VEP	4	3	1
Physical context	Not easy to use Crashed / not working Unclear message	Not easy to use (2) No new information Unclear message New information	New information
Socio-cultural context		Discussion (2) Influence companion's experience	Discussion
Personal context		Previous knowledge Not willing to wait	Relevant
Related to VEF	Not completing the activity Dissatisfied Confused	Doing the activity completely (2) Dissatisfied Not interested Confused Positive emotions Discussion (2)	Positive emotions Conceptual change Doing the activity completely Discussion Referencing new ideas to current knowledge