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Chapter 12
Using Mobile Technologies to Capture the Visitor Experience

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Abstract Museums give much consideration to how visitors experience their exhibits. Mobile technologies, such as apps on mobile phones and tablets can capture the visitor experience in an automated, on-the-spot manner. Two apps were designed and used to capture visitors' experiences of interactive exhibits at a science museum. Based on our observations, we discuss (a) the appeal of the technology, (b) the integration of this technology in the overall museum visit and (c) the processing of the collected experience data. Based on our observations, we recommend that museums and science centres critically evaluate the above-mentioned points when considering implementing mobile technologies to capture the visitor experience. Furthermore, we advise institutions to approach mobile technologies as *product service systems* and take into account the infrastructure that is required to make mobile technologies work.

12.1 Introduction

Rather than merely displaying artefacts as objects, museums nowadays tell stories and provide audiences with a rich historical, cultural and scientific context to their artefacts. Furthermore, museums—and science centres in particular—often rely on interactivity as a means to tell these stories in an engaging and playful manner. When institutions instal interactive exhibits in their museums and science centres, how can these institutions assess whether the exhibits are well received by the public and whether the interactive exhibits bring across the visitor experience they

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were designed for? Which means of measurement and quality control can be implemented, and how can mobile technologies be utilised towards this purpose?

In this chapter, we discuss how mobile technologies can be applied to capture visitor experiences with interactive exhibits, as well as how institutions can learn from this knowledge. We base our findings on two studies conducted at NEMO Science Museum in Amsterdam, in which we used two apps to capture visitor experiences in two different ways. With the first app, called the *photo*-app, visitors could take pictures of interesting moments while experiencing the exhibits and could then report their experiences using text. With the second app, called the *mirror*-app, visitors were asked to match their experiences of exhibits with a set of predefined experiences that were visualised in the app using animations (i.e. reporting the extent to which a visualised experience mirrored the visitor's experience).

We will first discuss the concept of experience, as well as issues of how to capture visitor experiences and of using mobile technologies in doing so. We then introduce NEMO Science Museum and the two mobile apps in more detail: how they are used and what data they provide. Subsequently, we discuss the findings of the exploratory field studies we conducted in the science museum, and reflect on critical issues in developing and implementing mobile technologies in a museum setting. Specifically, we reflect on the *appeal* of the technology, the *integration* of this technology in the overall museum visit and the *processing* of the resulting experience data. The chapter concludes by providing *recommendations* for museum institutions on how to best implement mobile technologies for assessing visitor experiences.

12.1.1 Experiences

What exactly do we mean by *experience* and how does this relate to the experience of interactive exhibits? In layman's terms, experiences are the things we see, feel and think about; the things we are consciously aware of and that are worthwhile mentioning in either positive or negative terms. In this section, we present some of the theories and models of experience as they are applied in the fields of industrial design, interaction design and heritage studies.

In their work on product experience, Hekkert and Schifferstein (2008) looked into how a design generates an experience. For them, experiences arise from the interaction between a person and a product. In trying to pinpoint the specific factors that influence the experience of an interaction, Locher et al. (2010) found that factors such as personality traits, skills and personal values play a role, as well as the embodiment of a design and the circumstances in which a design is used.

In the field of industrial design, Desmet and Hekkert (2007) have broken down the complexity of subjective experiences into three levels. The first level involves experiences stemming from our direct sensory impressions of the environment and is labelled *aesthetic experience*. The second, called *experience of meaning*, involves interpretations of our direct sensory impressions. The third involves emotional reactions to our environment and is labelled *emotional experience*. When we interact with artefacts, these levels are at work simultaneously; we have an aesthetic impression of a design, we interpret it in terms of its use and cultural significance, and a design elicits emotions in us based on our needs and concerns.

To illustrate the various levels of experience described above, we reflect on one of the interactive exhibits at NEMO Science Museum named ‘Mirror Drawing’ (Fig. 12.1, left-hand side). In this exhibit, visitors are invited to move a pencil to trace the diagram of a star while looking at their hand as it is reflected in a mirror. The visual feedback of the actions while drawing is mirrored and confronts us with our dependence on visual feedback in motor control. The aesthetic experience of this installation is formed by the formal sensory qualities of the exhibit: its pink colour, glossiness and rounded surfaces. The experience of meaning relates to the associations triggered by the exhibit; for instance, ‘fairy tales’ ‘and ‘magic mirror’. The emotional experience relates to, for example, the challenging task of trying to trace the star with a pen only via the star’s reflection in the mirror, or the good or bad memories one may have about ‘fairy tales’ or ‘magic’.

In the field of interaction design, the term *user* experience is used. Based on a large survey among experts in the field of user experience design and research, Law et al. (2009) found that although it proved to be difficult for these experts to agree on a shared definition of user experience, they agreed on the fact that user experiences are highly *context-dependent*, *subjective* and *dynamic*. *Context* was found to refer to, for example, the social, physical and activity context of a user.

Fig. 12.1 Mirror Drawing: installation at the NEMO Science Museum. © NEMO Science

User experience is considered *subjective* because the way in which something is experienced is highly dependent on characteristics of the individual who experiences it. It is seen as *dynamic* because experiences continuously change during an interaction.

Within the field of heritage, Pekarik et al. (2014) proposed an experience approach for exhibit design called IPOP that describes the different ways visitors can be attracted to exhibits. The name IPOP stands for Ideas (conceptual, abstract thinking), People (emotional connections), Object(s) (visual language and aesthetics) and Physical (somatic sensations). According to the model, different people have different preferences among these (which is in line with Law et al.'s finding that user experiences are seen as very subjective, or individually different).

Finally, in much of the literature on experience design, human needs are addressed in relation to what makes experiences pleasant and meaningful. For example, Hassenzahl (2010) states that the relation between actions and needs (or motives, values) is believed to colour experiences and to set their emotional tone. According to Hassenzahl (2010), 'understanding actions in terms of motives fulfilled is crucial to an experiential approach to design' (p. 45). He argues that needs categories can provide categories of experiences, which can be used to describe and classify many experiences with interactive products. For capturing experiences, this can be advantageous because the concept of needs as categories is grounded in sound and extensive psychological research (Hassenzahl 2010).

In sum, for assessing experiences, it is important to realise that experiencing something relies on interacting with it, that the way something is experienced is very context-dependent, subjective and dynamic, and that categories of human needs can be used for categorising pleasurable and meaningful experiences.

12.1.2 Capturing Visitor Experiences

How do museums and science centres assess visitor experience and how do institutions apply this information in their practice? As Beghetto (2014) mentions, the way exhibits are intended to be experienced is often not the same as they are actually experienced by the public. Thus, for museums and science centres, it is useful to gain insights into the *actual* visitor experience in order to improve their exhibits.

Different techniques are available to measure visitor experiences in museums and science centres. Sterry and Beaumont (2006) provide an overview of methods for studying families in art museums from both experimental and naturalistic approaches. Some of the techniques she mentions are surveys, focus groups, observations and interviews. An example of an experimental technique is the 'servqual' method (Nowacki 2005), while a naturalistic technique is presented by Coffee (2007).

In the field of experience design and research, Vermeeren et al. (2010) provided an overview of user experience evaluation methods and characterised the many methods that they found based on various features, one of which is *period of experience*. They highlight that in assessing experiences one can focus on conducting the assessment *before* actual interactions (e.g. noticing something before using it, anticipations of experiences), *while* interacting (as experiences are considered to be dynamic, see before), *immediately after* an interaction or *after having used something multiple times*. Another characteristic they highlight is the *location* where the assessment takes place (e.g. lab, field or online). Increasingly, mobile technologies can be and are being used for assessing experiences by having users self-report about their experiences at the location where the experience happens, at moments close to the actual moment of experiencing, thus potentially improving the validity of measurements.

In many cases, devices such as smartphones are used for sampling experiences by asking users to self-report their experiences. For example, Intille et al. (2003) explored the use of experience sampling on smart devices that allow different experience assessment strategies (e.g. multiple choice and multiple response questions). As mobile devices usually offer a wide range of functionalities, self-reports are often complemented by additional data for better understanding what was experienced. For example, in Ståhl et al.'s (2009) Affective Diary, measurements from body sensors and mobile media complement the self-reports. Li et al. (2013) developed an app for assessing emotional experiences of individuals in festival crowds. In their study, an app prompted festival visitors about the feeling they had at that time. The data were then related to their location at the festival. Based on this, crowd maps could be constructed that said something about the physical crowd dynamics as well as about experiences within the crowd.

12.2 Field Studies at NEMO Science Museum

NEMO Science Museum—ranked fifth on the list of best visited Dutch museums in 2015—lies in Amsterdam's harbour district and welcomes more than 500.000 visitors a year. Renowned architect Renzo Piano designed the green copper-clad building that looks like a ship rising from the waters above Amsterdam's IJ tunnel (Figs. 12.2 and 12.3). A wide range of fascinating topics are brought to life, from natural sciences and social sciences to neurosciences.

NEMO Science Museum consists of five floors full of exhibits that invite visitors of all ages to explore *hands-on* and *brains-on* the wondrous world of science and technology, to become tinkerers in different workshops, and even to become subjects in real scientific experiments. Key ingredients of NEMO's mission are to nurture curiosity, critical thinking and a questioning mind. To this end, NEMO has a strong focus on interactivity (for example, see Figs. 12.1 and 12.3).

One of NEMO's innovative research programmes is *Science Live*, which opens up the museum floor to scientific research with NEMO visitors participating as experimental subjects. NEMO Science Museum feels that science centres and museums should not only be about displaying science but also about encouraging

Fig. 12.2 The building of NEMO Science Museum. Designed by Renzo Piano. Picture by DigiDaan © NEMO Science Museum

Fig. 12.3 Impression of an exhibit floor at NEMO Science Museum. Picture by DigiDaan © NEMO Science Museum

its visitors to be part of the scientific process itself, enabling visitors, young and old, to experience how scientific knowledge is acquired and how the scientific method works. We explored the use of two apps for collecting visitor experiences in the NEMO Science Museum, as part of the Science Live programme.

12.2.1 Photo-App Field Study

In the photo-app field study, an app was used to evaluate a total of 12 interactive exhibits. The photo-app was installed on a small handheld device that visitors could take along with them while walking through NEMO Science Museum. The procedure for reporting their experiences via the app involved several steps: visitors first took a picture of the activity they were involved in at the exhibit, were then asked to type in a keyword that expressed the feeling they had during the activity, and were then prompted to use a visual ring for highlighting in the picture the area which produced this feeling. Moreover, visitors were asked to describe their engagement using four word pairs: *pleasant* versus *unpleasant*, *mind* versus *body*, *doing* versus *undergoing* and *alone* versus *together*. The process ended by rating the activity on a five-point scale according to how motivating they found it. The app could be used five times in a row in order to obtain feedback on a *series of experiences* while interacting with an exhibit. Figure 12.4 provides a visual overview of the reporting process.

A total of 255 visitors participated in this field study. Participants included a younger group of range 6–19 years (mean age 11, standard deviation 1.3) and an older group between the ages of 20 and 74 (mean age 43, SD 9.5). Visitors mostly arrived in groups. One group member was asked to be a participant in our study. Researchers assigned participants to a specific interactive exhibit and asked them to report on their experience five times while interacting with that exhibit. Participants could choose these moments freely.

Examples of the result of the capturing process are shown in Fig. 12.5. As can be seen, the data captured from a participant included a series of images of an interactive exhibit. These pictures are diverse: showing the exhibit as a whole or showing only a detail; showing the app user in action or showing someone else engaged with the exhibit. As an overlay on the image, a ring is placed that further highlights one's area of interest. Keywords entered by participants were describing their experience of the exhibit. These keywords ranged from affective comments to more factual ones. Below that, labels were placed that describe the engagement, as a result of how the four switches were set. For example, for the top-left photo, the engagement was described as 'unpleasant-mind-doing-alone'. At the bottom, a number is shown indicating the participant's level of motivation while engaging with the exhibit.

By combining all the experience keywords that participants expressed for an exhibit, a *word cloud* could be constructed that provided a visual overview: the higher the frequency of a word as compared to the other words, the larger the size of

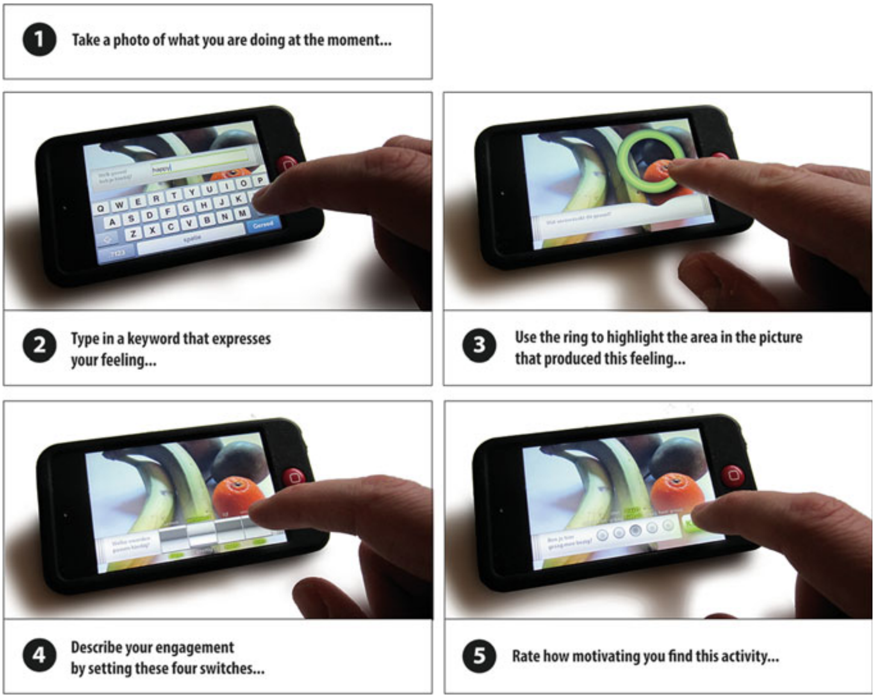


Fig. 12.4 Storyboard explaining the experience-capturing process of the photo-app

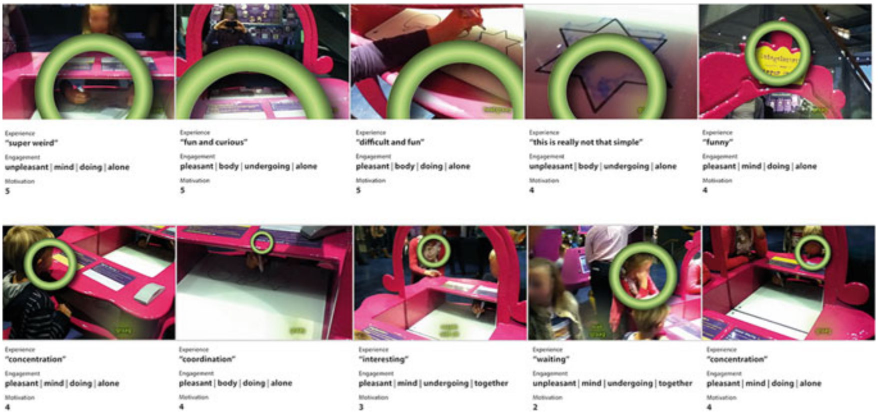


Fig. 12.5 Presentation of the combined output gathered by the photo-app for two participants

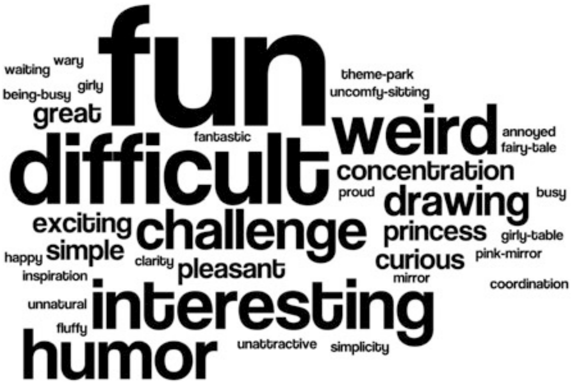


Fig. 12.6 Word cloud presentation of the keywords expressed by participants, based on 77 entries. The higher the frequency of a word as compared to the other words, the larger the size of that word in the word cloud. Translated from expressions in Dutch

that word in the word cloud (Fig. 12.6). The experience keywords for this study were categorised, considering spelling errors and different ways the same concept could be phrased in the simplest form. For example, the category 'Weird' included keywords like 'weird', 'weird feeling', 'super weird' and 'freaky'. These word clouds provide an intuitive description of how the interactive exhibit was experienced. One of the exhibits that visitors reported on was 'Mirror Drawing' (see Fig. 12.1). As indicated by the size of the words in this specific word cloud, many participants considered the exhibit to be about 'drawing' and found it enjoyable (see keywords 'fun', 'interesting' and 'humoristic'), but also 'weird' and 'difficult'.

The engagement labels can be summarised for each interactive exhibit. Figure 12.7 shows the engagement profiles of the 12 exhibits, which are constructed based on how participants set the engagement switches. The position on the vertical axis of the graph shows the *ratio between two positions of a switch*. When one position of a switch was chosen more often, its position on the vertical axis moves up or down depending on the direction the switch is set to. When both positions of the switch were selected equally often, its score moves towards the middle of the vertical axis (as indicated in the graph by the dotted line). Results are shown for each of the four switches separately (this is indicated by different colours in the graph). When looking at 'Mirror Drawing', results showed that participants felt *pleasantly* and *actively* engaged and that they were engaging *alone* and with their *minds*.

The rich data captured by the photo-app allow researchers to explore visitors' experiences of the exhibits in several different ways. For example, by combining the images and highlights with the experience keywords, a map can be created as shown in Fig. 12.8. Visitor experience can thus be mapped onto specific aspects of the exhibit, and thus reveal how different features stand out. The engagement mode switches can be used as additional filters. In order, for example, to selectively show experiences that relate to *social interaction* only, or to filter out the *negative experiences*, etc.

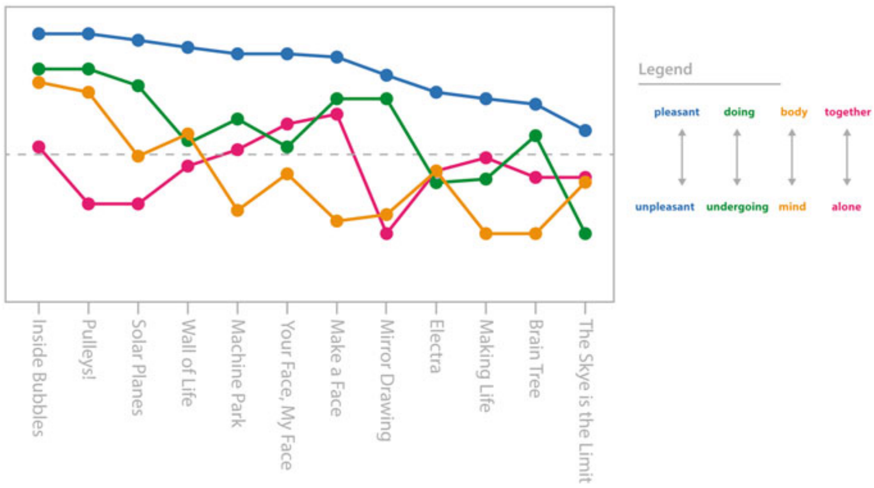


Fig. 12.7 Graph representing the 'engagement profile' of exhibits along four dimensions: pleasant/unpleasant, doing/undergoing, body/mind and together/alone

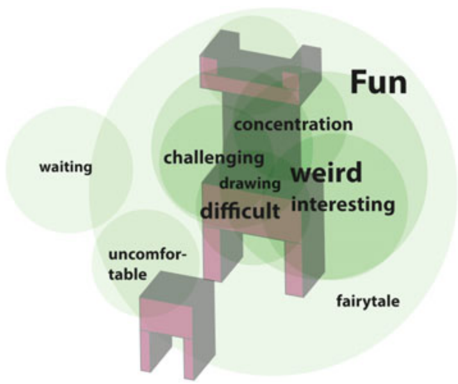


Fig. 12.8 Impression of an experience map of an interactive exhibit (Mirror Drawing) based on the captured data of the photo-app by combining keywords and highlight data

12.2.2 Mirror-App Field Study

In the mirror-app field study, a different app was used to evaluate 12 interactive exhibits. These exhibits were the same as the ones evaluated by the photo-app field study. The mirror-app was installed on a tablet computer, thus a somewhat larger device compared to the handheld device used for the photo-app. With the mirror-app, visitors could match their experience of an exhibit with the experiences depicted by an animated virtual puppet. The starting point and inspiration for developing the mirror-app was that designers of installations may have designed the installation with specific target experiences in mind. The app then was intended to serve as a tool to measure the extent to which the targeted experiences have been realised. To this end, the app had many puppet animations to choose from, each expressing a different experience. For example, when experiencing an exhibit as socially pleasurable, a visitor could select the puppet that displays socially pleasurable behaviour. The focus in the animations was on how the puppet interacts and what it feels like while interacting, *without using words*.

In total, 24 animations were created that communicated different experiences, relying solely on the puppet's movements and non-verbal vocal sounds (i.e. grunts, cries, laughter, etc.). The animations took about 3 seconds each and were looped, i.e. the animation ended where it started, thus allowing a never-ending cycle. Animations were grouped in six themes, inspired by psychological needs theory (Deci and Ryan 2000; Sheldon et al. 2001), and each theme consisted of four animations. For the theme 'physical effort', for example, the animations could be positioned in a quadrant involving *high* or *low* level of physical effort and be interpreted in a *positive* or a *negative* sense. Thus, each animation in the theme 'physical effort' had a specific interaction experience associated with it, namely, either 'relaxing' (*low-pos*), or 'apathetic' (*low-neg*), or 'energetic' (*high-pos*) or 'exhausting' (*high-neg*). A key requirement for developing the animations was that they had to express the four versions of a need in an abstracted way, only showing a puppet and an abstract object, so that they could be easily related to all kinds of different situations. For designing the animations, we explored the desired bodily behaviour of the depicted puppet, by first role playing the experiences ourselves, using a big cardboard box as an object, while making sounds that we felt fitted the experience. The role plays were video-recorded, after which requirements for the animated behaviour and sounds were described and forwarded to the agencies that developed the app. A visual style was proposed to the design agency, and several iterations of styles, animations and sounds were discussed and evaluated until the final version was decided upon. See Fig. 12.9 for an overview of all the themes used in the mirror-app.

The mirror-app was used in the following manner. Participants were asked to report their experience by using the app after they had interacted with an exhibit. In the app, all themes were presented to the participants in random order. The four animations within a theme could be selected by touching one of the four corners on the tablet screen. This would then play the corresponding animation. Therefore, participants could explore the four animations of a theme by moving towards each of the corners until they had identified the animation that best mirrored their own experience. Furthermore, touching the arrows on the left or right side allowed participants to move through the different themes, and numbers 1–6 on top of the screen allowed them to go directly to one of the themes they wished to report on. Headphones were used with the app to allow participants to better hear the sounds and to concentrate on the animations. Figure 12.10 provides a visual overview of the user interface.

A total of 122 visitors of the science museum used the mirror-app and shared their experiences of the exhibits. The same 12 interactive exhibits as in the photo-app field study were chosen for this study. Participants were children between 6 and 13 years of age (mean age 9, standard deviation 1.6). Before going

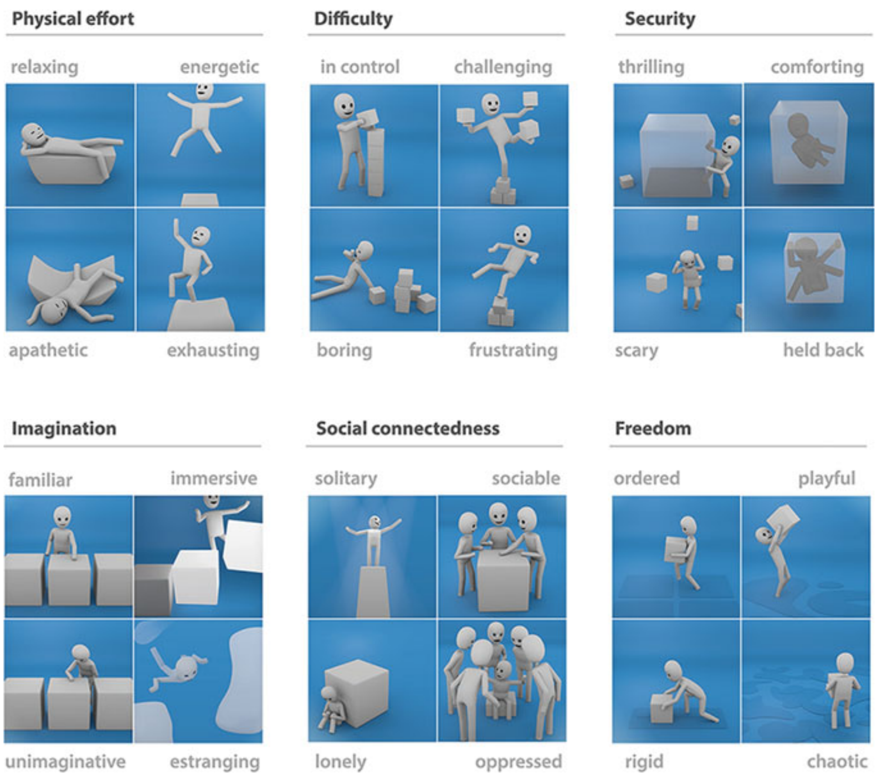
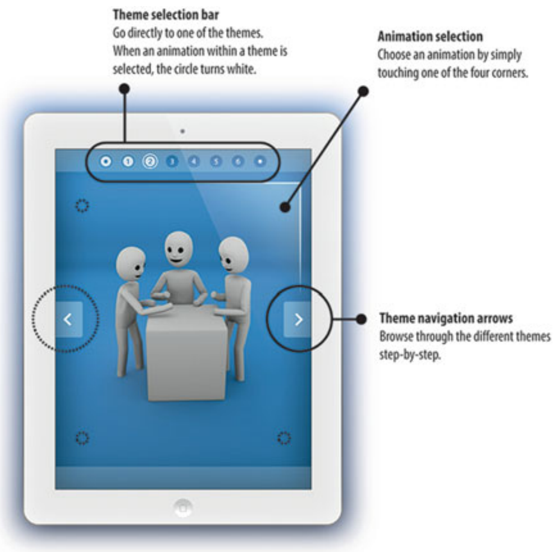


Fig. 12.9 Figure showing 24 experiences for six themes for a high or low level of a different theme (left and right side of a quadrant) and positive or negative affect (top and bottom side of a quadrant)

out to assess the exhibits, they were instructed about the use of the app, going through it once. We asked them to report their experience after they had familiarised themselves with an installation. This took them about 5–10 min. Similar to the photo-app field study, visitors came in groups. Thus, a participant experienced the exhibits in pairs or in small groups. One child in the group was asked to use the app. While using the app, the researchers asked the children to motivate their choices in order to examine their matching strategies (the reasoning for why they linked specific animations to their experiences of the exhibit). This was done to learn about the use and design of the app itself, rather than for learning about the installations.

The data collected by the app consist of frequency data, i.e. the number of times specific animations were chosen. The data can be presented in graphs to show how an interactive exhibit scores across the six themes. Figure 12.11 shows the data collected for 'Mirror Drawing'. The frequency data are presented in quadrants in which the positive experiences are green and the negative ones are red. The larger the quadrant, the more that animation was chosen compared to the other ones.

Fig. 12.10 Visual overview of the mirror-app user interface



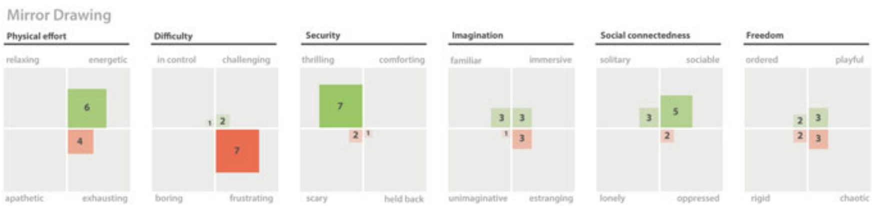


Fig. 12.11 Data visualisation of the results for 'Mirror Drawing' on six experience themes, based on data gathered from 10 participants

For example, when looking at the data gathered for 'Mirror Drawing', with respect to difficulty, this was rated as difficult in a negative sense (i.e. 'frustrating'). As for security, this was low but positive (i.e. 'thrilling'). With respect to physical effort, this was rated as high with about an equal division between positive and negative affect ('energetic' and 'exhausting', respectively). Apparently, tracing the star via its reflection in a mirror was a very difficult task to perform; nevertheless, it brought participants in a thrilling and energetic state. Visualisations like this can also be used to at the same time visualise the targeted experiences (e.g. in the form of outlined boxes) as well as the reported experiences for comparison purposes.

In sum, two apps have been designed for allowing people to self-report their experiences on location, during or immediately after an experience. The photo-app was developed mainly as a tool to gain a detailed and rich understanding of an interactive experience (through free text and 'switches'), also relating the experience to elements of the installation that had contributed to the experience (through the pictures and rings). Insights from using the photo-app are mainly for determining how to improve a specific experience (as in formative evaluations; e.g. see Roto et al. 2015), rather than for objectively determining whether a targeted experience has been achieved (as in summative evaluation). The mirror-app focuses on the latter. The measured data from the mirror-app are less rich, but can be used to quantify the extent to which a targeted experience has been achieved. It does so by disentangling the experience into various predefined experiential aspects and asking participants to score those.

12.3 Observations and Implications for Design

Based on the two conceptually different app designs and the way they were applied in NEMO, we can discuss how mobile technologies can be applied to capture visitor experiences. Our reflections concern (a) the *appeal* of the mobile technology to visitors, (b) the *integration* of the mobile technology in the overall visitor experience and (c) the *processing* of the mobile technology data. Based on our studies, we see these three aspects as critical for effectively implementing mobile technologies for assessing visitor experiences in museum settings.

12.3.1 The Appeal of Mobile Technologies to Visitors

We found that it is critical to design the mobile technology in a way that motivates visitors to share their experiences during their museum visit. Mobile technologies such as smartphones and tablet computers are commonplace nowadays; so many people are familiar with them and have no problem using them. However, design quality can be decisive for the extent to which visitors will be motivated to use these mobile technologies during their visit. The app design is critical for the aesthetic appreciation and usability of computing devices (Hassenzahl 2004).

During our field studies, we noticed that mobile technologies had a strong appeal to visitors, especially children. The user interfaces of both apps were designed to be intuitive, and visitors (young and old) learned to use the apps quickly. The functionality of the apps was based on moving through the questions step by step via simple swiping actions. Moreover, the emphasis was given to the appearance of the user interface: a sleek metallic look for the photo-app and a friendly white-blue look for the mirror-app. Furthermore, user interfaces that incorporated sound in their design have been shown to increase usability as well as the level of immersion one experiences during use (Nees and Walker 2009).

12.3.2 Integrating the Use of Mobile Technologies in the Overall Visitor Experience

We found that it is important that the mobile technology blends in with the overall visitor experience in the museum. We will reflect on the implementation of mobile technology with groups of visitors and the interplay between experiencing an interactive exhibit and reporting on that experience through mobile technology.

12.3.2.1 Social Use of Mobile Technology

Our studies in the science museum indicate that mobile technologies should be designed in such a way that their use does not disrupt the social interactions in a group. When an app is given to one of the people in a group, it soon becomes the focus of everyone in the group–*the mobile technology becomes shared*. We observed a mother helping her child type keywords, a child asking his father to take a picture of him with the interactive exhibit, but we also observed the impatience of people when the reporting process took too much time or when the apps could not be shared readily enough. In terms of the actual experience assessment, we observed people negotiating with each other, or discussing their views about an interactive exhibit.

The photo-app could be shared more easily than the mirror-app. The photo-app was smaller in size and did not make use of headphones and could, therefore, be more easily passed around in the group. Further, reporting with the photo-app could be easily done standing up while the mirror-app required one to sit down, hereby physically restricting one's freedom of movement. Moreover, the headphones isolated a person from environmental sounds and conversations. These observations clearly indicate a preference for the photo-app compared to the mirror-app concerning sharing.

12.3.2.2 Balancing the Interplay Between Experiencing an Interactive Exhibit and Reporting on that Experience

When developing experience-capturing techniques in the field, care should be given to ensure that the technique provides a *reflection time-out*, yet does not *distract people too much* from engaging with the interactive exhibits. When the required response is too fleeting, visitors might not take the time to take a step back to reflect on what was most important to them in the experience. When using the tool asks too much attention by itself, the experience of the tool dominates the experience of the interactive exhibit, and results might be skewed. Both apps imposed new experiences while interacting with an exhibit, albeit in different ways. With the photo-app, visitors were asked to *create content* (i.e. take a picture, provide a verbal response, etc.), while the mirror-app involved a *matching task*. In this respect, the mirror-app required less *cognitive effort* than the photo-app. However, we discovered that the long attention span required by the latter was difficult to maintain in a busy environment like NEMO, with the result that some visitors become annoyed, which may therefore have led to less accurate responses.

Another factor is the *media richness* of the mobile technology. Since the mirror-app involves animation with sound, it is more of a sensory experience compared to the photo-app. Rich media, in terms of sensory vividness, have the power to captivate (Steuer 1992). This was evident in the children liking and focusing on the animations so much that they forgot about the aim of the assessment. Although this made the app highly motivating to use, the data captured can be less valid as a result of this, as the experience of the app might have overshadowed the experience of the exhibit.

Furthermore, the *number of interruptions* can affect the balance between visitor engagement with the interactive exhibit, on the one hand, and the distraction factor due to the reflection time-out, on the other hand. The photo-app required participants to report on their experience five times in a row. This can be considered more intrusive, compared to only one report at the end of an interactive experience, as required by the mirror-app.

12.3.3 Processing the Collected Data

Our studies show that it is critical to obtain experience data in a way that is not only *insightful in general but also caters to the specific needs of the institution*. Do museums and science centres want to know about visitor experience for benchmarking or do they want to gain in-depth insights into how the interactive exhibits are experienced?

The two apps provided data about the visitor experience in different ways. The photo-app collected *qualitative* data (photos with highlights and keywords) as well as *quantitative* data (engagement mode and motivation scale). The mirror-app collected *quantitative* data only (number of times animations were selected). Assessing the visitor experience to gain *insight into visitors' motivations* favours a qualitative data approach, in which visitors (creatively) share their experience via rich media. This technique allows one to explore the individual experiences of visitors in detail. Assessing the visitor experience for *benchmarking* favours a quantitative approach, since different exhibits can then be easily compared on their performance using a set of predefined criteria. Due to their complexity, qualitative data are more difficult to use for benchmarking purposes.

When asking visitors to report on their experience of exhibits by typing in keywords (as with the photo-app) or by selecting animations (as with the mirror-app), they responded differently. In both studies, we observed many types of responses, ranging from mentioning *concrete* aspects of the experience, the *activity* one was engaged in, the *emotions* felt, the *ambience* of the experience, to a *judgment* of the experience. This variety was considered a strength in the photo-app since these descriptions together provided a holistic representation of the experience (as depicted in the word clouds). However, for the mirror-app, the different interpretations of the shown animations were problematic since this assessment technique assumed a common understanding of them.

Developments in data analysis techniques provide opportunities for processing both qualitative and quantitative data. Examples are analytical tools such as text sentiment and opinion analysers (Pang and Lee 2008). Such techniques allow keywords given by visitors to be monitored in real time, hereby automatically assessing the *affective tone* of an exhibit or overall museum setting. Another exciting development is 'photosynth' by Microsoft. With this technique, the researchers demonstrated how the 'Notre Dame' in Paris, France can be automatically constructed as a virtual model based upon the numerous pictures taken by tourists and uploaded on the Internet, a technique explained in detail by Snavely et al. (2008). Such technologies allow data mining of large amounts of user-generated content (i.e. texts and photos) and provide new opportunities for assessing the visitor experience in the future.

12.4 Recommendations for Museum Institutions

The insights gained through the design and evaluation of the photo-app and mirror-app led to several recommendations regarding the design and implementation of mobile technologies for capturing visitor experience in museums and science centres. After first summarising our findings, we will elaborate on mobile technologies as *product service systems*. Recommendations will be given on different levels of implementation.

In designing mobile technologies, the *appeal* of the technology is important in order to stimulate visitors to share their experiences. We recommend that emphasis be given to the design in terms of *usability* and *aesthetics*: mobile technologies should be intuitive in use, and their aesthetics should be appealing to the museum's audience. Furthermore, since the mobile technology may be *used in groups*, it should enable sharing. We recommend keeping the mobile technology compact, so that it can be *passed around* in the group, allowing freedom of movement, and so that it does not create a *sensory disconnection* from group members, something that the use of headphones can create. For the mobile technology not to disrupt the museum visit, we recommend to keep the capturing process *simple*, to keep the experience provided by the mobile technology *within boundaries* so that it does not overshadow the experiences that are provided by the exhibits proper, and to *limit* the number of interruptions to a minimum. In terms of data collection and processing, there should be a match between the needs of the institution and the type of data that are collected by the mobile technology. In general, collecting visitor insight favours a qualitative data approach whereas benchmarking favours a quantitative one.

For museums, it is important to realise that the two mobile technologies that we have designed should not be considered as stand-alone products, but rather as *product service systems*. Product service systems are aggregations of products and services organised around a specific functionality (Baines et al. 2007). With respect to the mobile technologies used in the current study, the app (as explained in detail in this chapter) is just one element of this system. Setting up this complete system requires an *infrastructure*, *database* and *visualisation software*. For example, a communication infrastructure required Wi-Fi hotspots to be installed in the museum floors for data to come through. A database had to be installed to store the collected data with the appropriate means for data protection. Specific consideration needs to be given to how the collected data can be meaningfully presented to museum institutions, so that they can make sense of it. Issues such as these may easily be overlooked by museums, but they are critical to the actual implementation and success of the product service system.

12.5 Conclusions

In this chapter, we presented two experience assessment apps that were used to evaluate 12 interactive exhibits at NEMO Science Museum. We discussed the application of the two apps with respect to the *appeal* of the mobile technology to visitors, the *integration* of the mobile technology in the overall visitor experience and the *processing* of the collected visitor data. Based on our observations, we recommend that museums and science centres critically evaluate the above-mentioned points when considering implementing mobile technologies to capture the visitor experience. Furthermore, we advise institutions to approach mobile technologies as *product service systems* and take into account the infrastructure that is required to make mobile technologies work.

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