

Hands on, mobiles on. The use of a digital narrative as a scaffolding remedy in a classical science centre

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This article examines an educational design experiment which aimed to support young people's involvement and reflection in the exhibition at a Danish science centre. The experiment consisted in the examination of the design and implementation of a mobile phone facilitated narrative, which was planned as a so-called scaffolding remedy in the hands-on based exhibition. The digital narrative, called EGO-TRAP, was developed using Design-Based Research as the overall methodological framework. The study of students' interactions in the exhibition suggests, among other things, that because of its quality as a digital narrative, EGO-TRAP scaffolds pleasurable engagement and counteracts the tendency of "random button pressing" that often occurs in classical science centre exhibitions. In this connection, the mobile phone plays an essential role due to the fact that it, as the favoured media by the young students, offers an experience which they describe as both personal and flexible.

Introduction

In recent years, there has been an increased focus on the potential of learning that takes place outside the formal school system, especially within museums and science centres (Drotner, 2008b; Henriksen & Frøyland, 2000). At the same time, it is well documented that science centres and other hands-on based exhibitions are challenged by the fact that

visitors in general are rushing from one exhibit to another without completing the tasks at the exhibits. Science centre visits often prove to be unstructured and unfocused, as the primary purpose is to socialise with friends (Paris, 1997; Horn & Kofod, 2004). Researchers in museum learning have thus emphasised the need for structuring and personalising the visitor experience within explorative exhibitions by means of narrative structures (Martin & Toon, 2005; Roberts, 1997; Kahr-Højland, 2010a).

This article presents an educational design experiment at a science centre in which a digital narrative was implemented with the intention of supporting young people's engagement and reflections in a scientific context without waiving the explorative aspect of a science centre visit. A mobile facilitated narrative entitled "EGO-TRAP – you have no idea..." was planned and implemented as a so-called scaffolding remedy at a Danish science centre. The idea was to exploit some of the qualities of the narrative, namely its ability of structuring, contextualising and personalising, as well as to exploit the close relations between most young people and their mobile phones. The idea was to reach out to young people by using something they fancy (i.e., their phones) and make them relate to something they generally do not fancy, namely exhibits about science.

"EGO-TRAP – you have no idea..." was developed as part of a research project under the research programme DREAM¹. This article presents some of the insights gained from the design, implementation and evaluation of EGO-TRAP (Kahr-Højland, 2010b). The article presents EGO-TRAP and explains in particular how EGO-TRAP was planned as part of a Design Based Research study with the aim of scaffolding, i.e., to provide directional guidance for the visitors in an explorative hands-on based exhibition milieu. Finally, the article presents some of the key insights from the study of young people's interactions in EGO-TRAP.

EGO-TRAP – a mobile facilitated narrative

EGO-TRAP, which represents the tangible product of a Design Based Research (DBR) study, was planned as an educational experiment which could complement the topic "Basic Scientific Training Course" in upper secondary schools in Denmark. EGO-TRAP basically consists of three elements: the already existing *hands-on* exhibits at the science centre Experimentarium, the visitor's *mobile phone* and a *narrative*. Or, more precisely, two narratives, since EGO-TRAP consists of three progressive levels and two narrative layers, referred to as *the personal test* and *the meta-narrative*.

First level: A personal and individual test

A visit in EGO-TRAP is initiated by a phone call which you receive on your mobile phone. A female voice ("the woman") welcomes you and explains that you are part of a personality test facilitated by the science centre. The first task, she says, consists in playing a simple PC game, *rat race*, where you have to keep a rat trapped in a maze as long as possible. After

this, the woman guides you from one exhibit to another within the main exhibition hall of the science centre. Each exhibit represents a post in a personal test. At each exhibit, you are prompted to enter your own expectations for the outcome. Once the task at the exhibit has been fulfilled, the woman calls you and assesses your result. She might say: “you were not quite as good as you predicted – let’s see if you are better at recognising tones”. The woman then guides you to the next exhibit (e.g., “Do you recognise tones?”). Also, you receive a map on your display showing the position of the next exhibit. The personal test represents the first narrative layer in EGO-TRAP. Once you have tried four exhibits, you receive a personal profile based on your performance. The woman then pairs you with the person in EGO-TRAP who matches you the best in the personal test. The coupling with a partner marks the transition to the second level of EGO-TRAP, which is the level of collaboration.

Second level: The level of cooperation – and arousing suspicion ...

The progress of the second level is similar to the first level. The woman guides you and your partner from one exhibit to the other, she urges you to enter your predictions and she evaluates you once you have finished the task. Unlike the first level in EGO-TRAP, the second level is about testing your ability to cooperate, e.g., by whispering secrets to one another at the “Satellite Dishes” or by cooperating in “blowing” a ball through a ring at the exhibit “Play with the forces of air” by means of air jets². The second level of EGO-TRAP is also the level where it becomes evident that the experience in EGO-TRAP is not just the personal test it pretends to be. At this level, you and your partner thus receive a phone call from a man who claims that he has hacked the system. The hacker claims to be in possession of evidence suggesting that “the woman” has a hidden agenda. The hacker warns you: “Don’t you consider her questions very strange? I think you have to be careful here! Do not trust that woman!”. The call from the hacker is the first of many and it marks the presence of another narrative layer in EGO-TRAP: i.e., the layer referred to as the meta-narrative.

Third level: Confrontation and insight

You and your partner have to decide whether you trust the woman or the hacker. If you trust the hacker, he leads you to the third and final level of EGO-TRAP constituted by a secret, secluded room identified by the hacker as the woman’s secret control lab at the Experimentarium. Together with your partner, you enter the secret room once the hacker has helped you break the code at the door. Inside the room, you are confronted with an animated rat who is speaking with the voice of the woman. It thus turns out that you and your partner have not been guided by a woman, rather the voice of the woman belongs to a rat who has mutated. The rat has gained control of a science lab and is now carrying out scientific experiments on human beings. You, your partner and the other visitors at the Experimentarium have taken on the role of participants in an experiment. When the rat realises that she has been revealed, she captures you in her lab. The only way you can escape from the trap, the rat says, is by conquering her in a video game. You are now presented

with a 3D version of the *rat race* game you played initially in EGO-TRAP. Only, now the roles have been switched as you and your partner take on the role as the rat in the maze, whereas the rat/woman is the one closing the doors. When you succeed in finding *the exit* door in the maze, the door to the secret room opens. The game ends and you are free to go. This marks the end of the experience in EGO-TRAP.

Two-way dialogue between visitor and science centre

In EGO-TRAP, visitors use their own mobile phones. Once visitors have signed up for EGO-TRAP, their phones are connected to a central server at the Experimentarium. From this server, the phone calls from the woman and the hacker are disseminated to visitors' phones. The server's choice of phone calls depends on the visitor's feedback to the system through the keypads of their mobile phones. In this way, EGO-TRAP offers a two-way dialogue between the visitors and the system (the woman and the hacker).

The experience runs in a WAP/GPRS session, which means that visitor costs are kept low. Today, the use of WAP/GPRS may seem archaic, but in 2006 when EGO-TRAP was designed, it was the optimal solution, as it made it possible to provide a two-way dialogue based on audio signals at a low cost. The price for sending and receiving information (i.e., pre-recorded phone calls and text messages) during the 1.5 hour long experience in EGO-TRAP is less than USD 1.00.

EGO-TRAP as an educational design experiment

EGO-TRAP was developed as an educational design experiment which could complement the "Basic Scientific Training Course" in Danish upper secondary schools. The ideal goal was to support the development of scientific literacy. In the design of EGO-TRAP, I have focused particularly on a part of scientific literacy which represents something new, namely the ability to critically reflect on the premise for the scientific information provided (Debo, 2000; Millar & Osborne, 1999; Kahr-Højland, 2010b). At the same time, I have focused on the special approach to learning associated with science centres, i.e., the idea that one learns by pleasurable engagement.

The classical science centre

The design of EGO-TRAP took its point of departure from a critical examination of the current learning environment at the Experimentarium and other "classical" science centres, i.e., science centres that are more or less directly based upon the ideas presented by Frank Oppenheimer, in his "Rationale for a Science Museum", prior to the opening of the world's first science centres (Oppenheimer, 1968). According to Oppenheimer, people learn best when you let them walk through a "forest of phenomena", where they can freely choose

which parts they want to interact with (Oppenheimer, 1968, p. 206). Common to the classical science centres is that they present scientific phenomena through hands-on exhibits which are displayed in an exhibition with no evident structure. The idea is that the visitors can stroll around in the “forest” of hands-on exhibits and interact with exactly the exhibit they want to experiment with. “Wheelchair Energy”, which is part of EGO-TRAP’s first level, is an example of a hands-on exhibit. The exhibit consists of two wheelchairs with a lemonade dispenser in front. At the exhibit, visitors are supposed to wheel the chair 100 metres as quickly as they can. While they are wheeling, lemonade will be dripping into a cup in front of them, corresponding to the energy they use. Once they reach the goal of 100 metres, they can drink the lemonade and thus regain the energy lost by wheeling the chair.

From hands on to minds on

The explorative hands-on approach has had massive success worldwide, not just in the thousands of science centres that have emerged since 1968, but also in more traditional historical museums, which are increasingly implementing the interactive communication style (Hein, 1995). Researchers talk about an actual paradigm shift in museum learning (Nowotny et Al., 2003; Quistgaard & Kahr-Højland, 2010; Pedretti, 1999).

However, seen from a learning perspective, the high degree of freedom in the hands-on based exhibitions implies significant problems. Visitor studies indicate that visitors at science centres often feel overwhelmed, bewildered and inadequate – a condition which manifests itself in visitors “browsing” in the exhibition, without completing the tasks at the exhibits (Walker, 2008). Figuratively speaking, a visit to an apparently unstructured hands-on exhibition often results in “random button pressing”. The average time a visitor spends at a hands-on exhibit has been measured to be less than 30 seconds (Walker, 2008; Paris, 1997). In other words, peace and contemplation are not what best describes a visit to a science centre. The feeling of insecurity is not conducive for learning, and several researchers in museum learning have therefore emphasised that interactive museums need to go from *hands on* to *minds on* (Hein, 1995, 1998; Hooper-Greenhill, 1999; Roberts, 1997; Hsi, 2003).

EGO-TRAP was designed using the basic idea that if hands-on based exhibitions, such as the one at the Experimentarium, should represent a true complement to the formal school system, it is necessary to give the visitor more directional support (i.e., *scaffolding* for the visitor, see below). This can be done by creating a more visible structure in the exhibition (Bruner, 1990).

The intention of using two narrative layers in EGO-TRAP

The educational experiment in EGO-TRAP basically consisted in structuring the visitor experience at a science centre by means of a narrative. Whereas cultural-historical museums have a long tradition of scaffolding their visitors by means of, e.g., treasure hunts or

narrative structures, the use of a guiding structure goes against the basic principles and the great idea of the explorative science centres. As an example, the introduction of the electronic guidebook at the science centre Exploratorium in 1998 was planned as a provider of additional information to the exhibits selected by the visitors rather than a guiding remedy (Hsi, 2003). In the design process of EGO-TRAP, the challenge thus consisted in creating a structure which at one and the same time offered directional guidance in the exhibition and supported the possibility of free exploration.

EGO-TRAP contains two narrative layers³: the personal test and the meta-narrative. In the personal test, the visitor takes on the role of a test subject who works to gain insight into her own abilities. The exhibits in the science centre and “the woman” represent the helpers for the visitor who is trying to achieve the target (i.e. insight into her own abilities). In the meta-narrative, the visitor is still the main character, but the goal is no longer represented by insight into her own abilities; rather the goal is to gain insight into the underlying premises of the exhibition: Who is the woman in reality? Who is behind this exhibition? And what is the meaning of it? The helpers in this project are represented by the partner, the hacker and the mobile phone (which the visitor can use to call other visitors in order to discuss the matter).

The test story was planned with the aim of inviting young people into the exhibition (get them “on the hook”), by offering them a role with which they could easily identify. The test metaphor made it possible to involve predictions and evaluations as a natural part of the process at the exhibits. Having conspiracy theory as the bearing metaphor, the meta-narrative was expected to encourage the visitors to reflect critically on the experience and by that deconstruct the principles behind the set up in EGO-TRAP. Figuratively speaking, the revealing of the rat was supposed to be similar to pulling the rug out from under the visitors. This was expected to prompt them to step back and relate to the narrative as a narrative. In particular, the idea was that the visitors should use their partners to discuss the exhibits as well as the mystery about the woman and the hacker.

Mediated learning and scaffolding

The design of EGO-TRAP was based on a socio-cultural approach to learning (Vygotsky, 1978). In the planning of the educational design of EGO-TRAP, the concepts *mediated learning* and *scaffolding* were of particular interest. *Mediated learning* is fundamentally about organising and facilitating learning for someone. Learning is disseminated – mediated – best by using different kinds of means (described by James Wertsch as *mediational means*), such as language and artefacts (Wertch, 1998). *Scaffolding* is basically about helping a learner in the process of learning. The concept is related to Vygotsky’s theory of the Zone of Proximal Development (ZPD). According to Vygotsky, one can distinguish between two competencies in children, namely what the children can do on their own, and what they can do with help from a more competent other (Vygotsky, 2000, p. 188). The latter competence, Vygot-

sky states, is the one that propels the development process further than the child could have done on his own. Using the terminology of Jerome Bruner, the more competent other builds scaffolds of knowledge around the learner. In 1976, together with his colleagues, D. Wood and G. Ross, Bruner presented the concept of scaffolding for the first time:

More often than not, it involves a kind of “scaffolding” process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts. This scaffolding consists essentially of the adult “controlling” those elements of the task that are initially beyond the learner’s capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence (Wood, Bruner & Ross, 1976, p. 90).

Since its formation in 1976, the concept of scaffolding has been adapted and applied in a wide range of areas, not just teaching (e.g., Gibbons, 2002), but also, for example, within business organisation (Hedberg, 2005) and the organisation of creative processes (Phillipsen, 2010). Today, scaffolding is no longer narrowly understood as adults supporting children’s learning, rather it is understood more broadly as *directional support of learning processes*.

It is in this broad sense – to give directional support – that the concept of scaffolding has been used in the design of EGO-TRAP. In this case, scaffolding is defined as “taking the learner at hand” and guide her in the learning process.

In the case of EGO-TRAP, a special type of learning is mediated, namely, scientific literacy, which is the ability to manage and articulate scientific signs (Kahr-Højland, 2010 b). In EGO-TRAP, educational mediation is constituted through a mobile-facilitated narrative that seeks to support and guide the learner on a practical as well as on a mental level within the exhibition. On the practical – technical – level, EGO-TRAP is providing scaffolding for the visitors by helping them to navigate in the exhibition (Where am I going? How do I find the exhibit? What am I supposed to do at the exhibit?). On the other hand, the directional guidance on the mental level is about supporting the visitor’s reflections on her experiences in the exhibition, partly by means of social learning processes (this is elaborated later in the article).

The mobile phone as a material and immaterial tool at one and the same time

The mobile phone plays a key role in the process of scaffolding. The mobile phone functions primarily as a tangible tool for directional guidance. Besides this, the mobile phone functions as a linguistic tool which supports the visitors’ meaning making by, among other things, prompting conversation between the users (after the match making on the second level of EGO-TRAP). Using the terminology of Vygotsky, the mobile can thus be described as a tool which is both material and immaterial, and by that it constitutes an empirical

example of what has been described theoretically by Kirsten Drotner in the article "Boundaries and bridges: Digital storytelling in education and media studies". The digital communication technologies of today, Drotner states, imply that it is no longer appropriate to maintain Vygotsky's distinction between material and immaterial tools (Drotner, 2008a).

Furthermore, the phone has a dual function as a scaffolding tool in EGO-TRAP. The function of the phone as an immaterial remedy of scaffolding represents in itself a duality, as the phone is thought to work as a competent other that supports both individual reflection in relation to the specific exhibits, while at the same time causing critical dialogue and reflection by supporting the establishment of a reciprocal scaffolding relation between the visitors (after the match making on the second level). Finally, there is a very special reason for using the mobile phone as the remedy of scaffolding in EGO-TRAP. The phone constitutes a personal remedy used for communication and production of social identity by the young target group, and by that the mobile phone distinguishes itself from other mobile digital devices, such as personal digital assistants (PDA) (Stald, 2008). Young people experience a personal relationship with their mobile phones, and some of them even describe their phones as extensions of their own bodies (Kahr-Højland, 2010b, p. 52). Figuratively speaking, one can say that mobile incarnates (embodies) the classical educational imperative "discuss", which traditionally has been used as a scaffolding remedy in textbooks (e.g., "discuss the possible causes of the greenhouse effect").

The narrative as a remedy of scaffolding

EGO-TRAP was designed with the aim of providing scaffolding for the visitors in the exhibition hall, technically as well as mentally. An in-depth argumentation for the choice of the narrative as the primary remedy of scaffolding is available in the thesis "Learning is not a joke" (Kahr-Højland, 2010 b, chapter 6). The choice of the narrative was based on, among other things, results from cognitive psychology (represented by, e.g., Jean Mandler, 1984, and Jerome Bruner, 1986, 1990) and sociolinguistics (represented by William Labov, 1972). In particular, research results from these fields indicate that the narrative possesses some intrinsic qualities in terms of its structure. Cognitive psychology studies have shown that there is a close relation between narrative and human cognition. We use the narrative structure as a tool for understanding ourselves and our surroundings (Mandler, 1984; Bruner, 1990). In his socio-linguistic studies, Labov demonstrates that the narrative possesses a built-in evaluation dimension. The evaluation relates to the question of who is telling the story and why this particular story is being told. In this way, Labov's evaluation dimension connects the social context with the domain of the narrative. According to Labov, the evaluation dimension implies a distance between the narrative and the audience, and because of that, he says, the narrative points to itself as a narrative. By drawing attention to itself as a narrative, the evaluation dimension supports meta reflection (Labov, 1972). So, according to Labov, there is something about the narrative *eo ipso* which urges the audience to

reflect on the narrative as a narrative. These built-in qualities of the narrative as a scaffolding remedy are all related to the structure of the narrative. The theoretical perspectives on the narrative from Mandler, Bruner and Labov can be summarised as follows:

- The narrative organises information in a meaningful way as it provides a recognisable context and by that supports human comprehension (Mandler, 1984; Bruner, 1990)
- The narrative represents a well-known framework which is decoded easily by a broad target group (Mandler, 1984; Bruner, 1990)
- The narrative holds the possibility of containing several systems of meaning, running in parallel: thus, the narrative can function on an elementary level of action as well as on an additional level of affection (designated by Bruner as *the landscape of action* and the *landscape of consciousness*, respectively). This makes it possible to engage people on several levels (cognitively and affectively) and makes it possible to challenge a broadly defined target group (Bruner, 1986)
- The narrative scaffolds reflection by encouraging different interpretations rather than calling for clear-cut answers (Bruner, 1990)
- The narrative calls attention to itself as being a narrative, and by that it scaffolds meta-reflection (Labov, 1972).

The over all aim of the educational design (EGO-TRAP) was to engage visitors pleurably and to make them reflect critically on their experiences in the exhibition. EGO-TRAP was planned as a part of a science centre exhibition which has play and exploration at its core. It was important that the design urged the visitor to participate actively, and the narrative was thus planned with the aim of supporting what Mihaly Csikszentmihalyi calls *flow* as well as *social learning processes* (Wenger, 2003).

Flow

Flow is often described as the positive feelings we get when we are deeply engaged in activities. According to Csikszentmihalyi and Hermanson flow is:

A state of mind that is spontaneous, almost automatic, like the flow of a strong current (...). When goals are clear, feedback is unambiguous, challenges and skills are well matched, then all of one's mind and body becomes completely involved in the activity (Csikszentmihalyi & Hermanson, 1995, p. 70)

Achieving *flow* is basically about being sufficiently challenged. In order to challenge a broad target group "sufficiently", the experience has to be framed in a way which is both flexible and user sensitive. By experimenting with the balance between what is known and what is unknown, the narrative possesses a potential for scaffolding *flow* experiences in a

broad target group. By using a well-known form (e.g., “once upon a time...”), the narrative has the possibility of inviting a broad target group to participate. After that, the narrative may challenge the audience by experimenting with the form, e.g., through the development of an unknown content or by introducing alternative narrative styles and structures. The narrative is characterised by the fact that it, at one and the same time, represents something known (due to its structure) and yet something unknown (we do not know the story before it has been completed).

In order to be true to the explorative context for which EGO-TRAP was designed, the narrative was planned with the aim of scaffolding flow. Furthermore, EGO-TRAP was planned to scaffold critical reflection by supporting the establishment of “room for reflection” constituted by *social learning processes*.

Social learning processes

According to Etienne Wenger, knowledge should not be considered something that is transferred from one individual to another. Learning, Wenger states, is created through participation in a practice; it is a negotiation of meaning which ultimately leads to the production of identity. The negotiation of meaning can be both verbal and nonverbal. When we negotiate meaning, we do not start from nowhere: “meaning is not pre-existing, but neither is it simply made up”, Wenger states. “Meaning is neither in us, nor in the world, but in the dynamic relation of living in the world” (Wenger, 2003, p. 54). According to Wenger, knowledge occurs through a constantly ongoing negotiation of meaning between the individual and her surroundings. This negotiation of meaning takes place in different *communities of practices*.

EGO-TRAP was planned in order to realise the narrative’s potential for scaffolding social learning processes by imitating such a community of practice. The ideal goal was that young people should be mutually engaged in the tasks they are facing, both within the framework of the personal test (i.e., test of their ability to cooperate) as well as the meta-narrative (i.e., the revelation of the woman/rat).

The benefits of using the mobile phone

The mobile phone was chosen as the bearing technology for the realisation of a narrative that would scaffold both pleasurable engagement and critical reflection. The choice of the mobile phone was based on several factors. The mobile phone is a powerful data processor, capable of orchestrating complex information, and since most people bring their own mobile phones to the science centre, there are both economic and practical benefits of using private mobile phones as the facilitators of the narrative. Also, the users’ familiarity with their mobile phones allows for the possibility that the phone can function as an “invisible” platform of communication, i.e., what Don Ihde refers to as a *transparent medium*

(Ihde, 1990). Finally, several media researchers have elucidated that mobile devices support both individual and social learning processes (Walker, 2008; Fitzpatrick, 2007). The mobile phone thus tended to be an obvious choice as a facilitator of both the “individual” narrative layer (the personal test) and the “social” narrative layer (the meta-narrative) in EGO TRAP.

At the time of the design and launch of EGO-TRAP (2006), museums and science centres worldwide were experimenting with the use of Personal Digital Assistants (PDAs), mobile phones and other types of digital tools. Examples of the use of PDAs include: “The Water’s Way” at the Universeum in Sweden, personalised learning trails at Kew Gardens in London, “Land of Possibilities” at the National Museum in Denmark and PDA Tours at the Tate Modern in London. Examples of exhibition experiences facilitated by mobile phones at that time included: “Sense” at the Liberty Science Center in New Jersey, “Guide By Cell” at the Morrison Planetarium in San Francisco and “Ping” at The Hall of Science in New York. “The Activity Game” at the Bloomsfield Science Museum in Israel represents an example of a museum which developed an experience based on a digital device developed especially for that particular purpose. However, we found no examples of mobile phones used as facilitators of digital narratives with a two-way dialogue as in the case of EGO-TRAP. Since EGO-TRAP was launched, many things have happened within the field of digital museum experiences. As an example, in 2009 The Smithsonian in Washington, DC, launched the “Ghost of a Chance” experience, which is a treasure hunt based on text message services (sms) that take place both online and “onsite” at the museum. The London Botanical Garden, the American Museum of National History and SF MOMA represent other examples of museums or science parks that have developed mobile facilitated narratives or treasure hunts since then.

Since the time of the launch of EGO-TRAP, digital technologies have developed rapidly. Today, four years after the launch of EGO-TRAP, you can download apps that generate narrative trails or treasure hunts anywhere you want. The only thing you need is a smart phone (see for example www.interactivespaces.com). The WAP/GPRS technique that constitutes the nucleus of the EGO-TRAP experience and which made it possible to establish a two-way dialogue based on audio in 2006, is already out-dated. Technically, EGO-TRAP has been run over many times by treasure hunts and digital narratives. But still, EGO-TRAP stands out due to the fact that it implies an audio-based, two-way dialogue and due to the fact that it does not provide additional information to the exhibits, rather it provides a narrative which figuratively speaking pulls the rug from under the audience by the revelation of the woman/rat and through its challenge to the authority of the science centre.

Empirical studies regarding EGO-TRAP

EGO-TRAP was developed within the methodological framework of Design-Based Research (DBR) (Baumgartner et al., 2003; Barab & Squire, 2004). DBR is characterised by three core concepts: (1) intervention, (2) participation and (3) theory (Baumgartner et al., 2003, p. 5).

This means that – using the present study as an example – the researcher goes into (intervenes) an already existing learning context (the Experimentarium). The researcher makes focused changes in the context (in this case, adding a narrative structure to the exhibition at the Experimentarium). These focused changes, which constitute the new educational design (EGO-TRAP), are grounded partly in a theoretical basis and partly in collaboration with staff from the specific learning context (in this case, staff from the development department at the Experimentarium). The new educational design is adjusted on the basis of continuous cycles consisting of design, testing, evaluation and re-design (Baumgartner et al., 2003). EGO-TRAP was the result of a design process including a total of four iterations. The refinements and adjustments of the educational design (EGO-TRAP) were based on empirical studies in the exhibition.

It is important to note that EGO-TRAP should be seen as a prototype, i.e., as a product, that eventually came out of the DBR study. The study of EGO-TRAP does not deal with digital narratives within museums and science centres in general. Planned as a DBR project, the study of EGO-TRAP focuses on actual actions and behaviours framed by the “focused changes” within the exhibition. EGO-TRAP should be seen as an attempt to try out theories (about the narrative) in practice. It should be seen as the tangible product derived from a humanistic study, and as such, it should be seen as a prototype from which we can learn and build upon in future educational designs.

Data analysis

The data analyses in EGO-TRAP were planned as a qualitative study, following Flick (2004) and Kvale (1997). More than 300 students from upper secondary schools and elementary schools tested EGO-TRAP in various stages of the iterative design process in the period 2007-2008. The primary group of informants consisted of three classes from upper secondary schools. From each of these three classes, two students – one boy and one girl – were selected for video recording and subsequent semi-structured interviews. These six students constituted the core informants in the study. The selection of the key informants was based on the criteria that they should be average students in the topic of science and that they would not be too disturbed or anxious by the fact that they were going to be video recorded. The students were interviewed about two weeks after their visit in EGO-TRAP. These interviews were planned as semi-structured interviews in line with the suggestions by Steinar Kvale (Kvale, 1997). The interviews were partly planned on the basis of the initial analysis of the video recordings in which the informants were shown clips during the interview; in part, the interviews served as a way of deepening and putting into perspective observations from the video recordings (for example, special facial expressions or other kinds of behaviour which had been observed in the initial analysis of the video recordings). Also, the interviews served as a way of pinpointing new entry points for the further analysis of the video recordings. The data analysis was thus carried out as a hermeneutical

going-forth-and-back between video recordings and interviews, as the observations from the video recordings partly structured the interviews, just as points from the interviews were determining the further analysis of the video recordings (for further information on the empirical study, see Kahr-Højland, 2010 b).

The data analyses were based on transcripts of approximately ten hours of video recordings and eight hours of interviews from the key informants. The video transcripts were completed with the aim of covering as many semiotic levels as possible, in order to prepare an analysis that was as open and exploratory as possible. The transcriptions describe, among other things, the subjects' facial expressions and gestures; their movements in relation to each other, the exhibits, and the mobile phones, as well as their dialogue during the experience in EGO-TRAP. Based on the theoretical framework of the project, the analysis was carried out with special regard to investigate how the narrative layers work in relation to the engagement of individual students and the possibility of achieving flow as well as their development of critical reflection by means of social learning processes. Following the suggestions of Brigitte Jordan and Austin Henderson, the data were coded following both a vertical and a horizontal structure (Jordan & Henderson, 1995; Kahr-Højland, 2010).

Insights gained from the study of EGO-TRAP

The examination of young people's interactions in EGO-TRAP suggested that the personal test framed the students' experiences at the hands-on exhibits in a meaningful way. One of the key informants, Ben, represents an example of this. The previously mentioned exhibit "Wheelchair Energy" is part of the personal test in EGO-TRAP. When Ben arrives at the exhibit it is crowded by small children who are playing at the wheelchairs. Ben, who is a tough high school guy, sits down and wheels the chair side-by-side with the small children. He gives everything he has got and he swears when it occurs to him that he did not perform as good as expected. Seen from the outside, the situation with Ben at the wheelchair exhibit resembles a grown-up man playing with toddlers at the playground. But Ben does not describe the experience like that. In a later interview he explains that he was eager to get the best possible result at the wheelchairs, and to him it was just as if the woman wanted him to "bite the dust" (Kahr-Højland, 2010, p. 71). Ben's description of the experience suggests that the personal test has framed the experience at the wheelchair exhibit in a way that makes it relevant and meaningful to him as a teenage guy, even if it is inundated with small children.

The students describe how the personal test balances the known with the unknown in a way that challenges them "adequately" (cf. Csikszentmihalyi's theory about flow). Several of them describe how the combination of a well-known structure (find the exhibit, make your prediction, do the activity, assessment) with something unknown (we do not know where the phone will take us next time) meant that they felt confident in the experience while at the same time they felt challenged.

As one of the informants, Anna, explains, it was:

(...) Very amusing that you could give your feedback and things like that, I also think it was fun that you did not know what was next to come. So, instead of getting hand outs where it says that you're supposed to do this and that (...) it was quite amusing that I was totally unprepared for what was next and what I was supposed to answer (Kahr-Højland, 2010b, p. 70).

Informants show signs of pleasurable engagement and several of them describe feelings that are similar to flow. The informants often spend more than 1.5 hours in the exhibition, and they try the exhibits in EGO-TRAP again and again. They remember the exhibits and the results – both their own and others – for several weeks after the visit. In the case of the students testing EGO-TRAP, the digital narrative thus tends to counteract the propensity for random button pressing that often is the case at classical science centres like the Experimentarium.

As regards the meta-narrative, the examination of students in EGO-TRAP indicates that the engagement in the personal test to some extent happens at the expense of the engagement in the meta-narrative. The students are engaged in the sense that they act on the meta narrative (as an example, they run to the secret “rat room” according to the hacker’s instructions), but in their description of the experience in the exhibition, it is the personal test that has left the strongest impression. Again and again the informants go back to the results of the test (“Louise was the only one who performed better than me”, “I was coupled with the most talented boy in our class!” “How *unfair* that I was paired with a handball player” etc.). As discussed in Kahr-Højland (2010b), this may be due to the veritable clash of genre that is the case between the personal test and the meta-narrative. The personal test invites young people into a well-known universe. Due to its fundamentally positivistic input-output metaphor, it is not at all far from the formal school context with which they are very familiar. The presence of the hacker marks a shift to a completely different narrative that questions the fundamental premises for the information provided for the visitor. The hacker initiates discussion and debate – he urges the young people to call each other in order to discuss the woman’s role – and in this way the meta-narrative is drawing on elements from the genre of computer games played by the students in their leisure time.

Some of the students indeed reflected critically on the premises of the conclusions in some of the exhibits. But seen from an overall perspective, EGO-TRAP does not provide scaffolding for the students to reflect critically on the premises for the students to a very great extent. The ideal goal of the meta-narrative was to make the students step back and look critically at the premises for the information provided, together with their partners they were supposed to discuss the roles of the woman and the hacker. They do not. Actually they do not talk much at all during their stay in EGO-TRAP. Instead, there tends to be another kind of communication occurring in EGO-TRAP. The study of EGO-TRAP shows that the students are using EGO-TRAP as a platform for non-verbal negotiation of identity.

Video recordings and interviews show that the students are actually *performing* for each other in the exhibition. The students use their own as well as others' performances in the exhibition to maintain or generate a position in the already existing community of practice in the high school class (for details see Kahr-Højland, 2010b).

In these non-verbal negotiations of identity, the mobile phone apparently plays a decisive role. One of the reasons why the students are practically not communicating with each other verbally may be ascribed to the fact that their partners receive the same audio messages synchronously in the exhibition. The young people are aware of the fact that they receive the same messages from the woman and the hacker. So, often when they listen to messages on the phone, a single gaze on the partner is enough to confirm the next move: "OK, we go to the exhibit about colours" or "Off we go to the secret room!" etc. In this way, the mobile tends to be functioning as a common platform of consciousness – or communication platform – for the students in EGO-TRAP. This means that they feel no need to articulate their strategy for moving forward. Everything has been said already on the phone.

Also, empirical evidence from EGO-TRAP suggests that young people have a high degree of familiarity with their mobile phones as a technology. Several of the informants solve technical problems during their trips in EGO-TRAP, and none of the young people consider the phone as a barrier between themselves and the exhibits. As one of the informants put it, they are used to be carrying the phone "24-7". Some of the students report that it would have been a different matter if they had had to use a "foreign" device, e.g., "a giant walkie talkie" (Kahr-Højland, 2010b, p. 81).

In general, the students regard the phone as their own personal tool, and several of them report that they thought it was amusing to use their private mobile phones in a new context and that the phone personalised the experience for them. Some of the students describe the mobiles as personal assistants. For example, one of the students states that he "followed his phone" while another explains that the "phone found us" (Kahr-Højland, 2010b, p. 80). This almost personal relationship with their phones may be part of the reason why the students describe the experience with the woman and the hacker as extremely realistic. One of the informants states that: "I was thinking: Can she really see me? I just stood like that and looked around (laughs) (...) I was actually in doubt (...) whether she could see me or not" (Kahr-Højland, 2010b, p. 81).

The potential of digital narratives as remedies for scaffolding within science centres

The insights gained from the educational design experiment EGO-TRAP suggests that mobile phones can help to create a personal, flexible path through an exploratory exhibition environment. The study of EGO-TRAP also shows that the phone supports non-verbal social learning processes without disturbing the interactions between visitor and exhibit. In other words, it is possible to use a mobile facilitated narrative as a scaffolding remedy in a

hands-on based exhibition, without thereby giving up the explorative aspect of exhibition concept.

EGO-TRAP did succeed in providing scaffolding for the students in a way that they fulfilled the sequences at each exhibit. The students tried the exhibits again and again, and several of the students continued playing in the exhibition after the experience in EGO-TRAP had ended. The students remembered the results from the test several weeks after the visit. In this way EGO-TRAP seems to address the problem of “random button pressing” that tends to characterise visits to science centres. As a “museum guide”, EGO-TRAP is indeed well-functioning. As regards the meta reflective processes, EGO-TRAP did not provide sufficient scaffolding for the visitors.

EGO-TRAP should be seen as an experiment, a first modest attempt of structuring the explorative experience at a classical science centre, and as such it succeeded. The technique of EGO-TRAP has been run over long ago. The next more ambitious step as regards digital storytelling within museums might consist in creating narratives that, firstly, are more directly related to the content matter of the exhibition and, secondly, are supportive of discussion and reflection in a more direct way.

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Notes

1. DREAM (Danish Research Centre on Education and Advanced Media Materials) is a national research consortium working with web 2.0 based learning at museums (<http://www.dream.dk/>).
2. At "The Satellite Dishes", the visitors are urged to whisper messages to each other over a great distance by means of two large satellite dishes. The visitors sit with their backs turned against each other and whisper directly into the focal points of the dishes. In "Playing with the Forces of Air", the participants have to balance a ball on a stream of air flowing out of a cone. If the visitors cooperate in controlling the air flow and the ball, they may be able to push the ball through a ring.
3. The development of narrative layers in EGO-TRAP is based on Jerome Bruner's definition of a narrative. According to Bruner, a narrative contains as a minimum an actor, who acts in a recognisable environment by using specific means. Often there will be a problem that propels the narrative from an initial situation (an ancient order) to a termination situation (a new order) (Bruner, 1999, p. 161).

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