

# Technology, participation and bodily interactions in nature: The potential of mobile technology in situated learning

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**Abstract** In this study, we test and discuss a Danish communication and entertainment mobile application (app) aimed at children aged 10 to 12 years for use by families and schools. The app, *Tidslommen*, has been developed by Museum Vestsjælland, a collaboration among natural history museums in Denmark. *Tidslommen* features audio and video guides and augmented reality with game elements, which become active when users enter specific geographical spots. Adopting a transdisciplinary approach (media study, studies in children's culture, educational neuroscience, educational anthropology) and using a combination of the walkthrough method and sensory ethnography, we explore the functionalities of the app at four locations. With our field-based user experiences as the point of departure, we analyse and discuss the potential and challenges related to the intersections among bodily and nature-based experiences, mobile technology and participatory practices as part of a didactic setting that aims to encourage children to participate in experiences with nature. Our study suggests that using mobile technology encourages interactions between peers and moving around at a location. The app also allows for an individualised experience characterised by a play-oriented approach to the location.

**Keywords** App-based activities, affordances, play, nature experiences, museum communication

## INTRODUCTION

In the last decade, mobile technology has changed how children gather information, communicate, play and learn, as well as the place for these activities. Mobile media has become a means for participation, creative production and interaction between peers (Jenkins et al., 2006, 2015; Boyd, 2010, 2014). New technology is an essential part of many play practices (Johansen, 2016; Karoff, 2013b) and has grown to be a central tool in learning environments as well (e.g. Arnseth et al., 2018). The modalities and affordances of technology both expand educational opportunities and create new entry points for participation, and at the same time set the boundaries for interactions (Elleström, 2021; Hutchby, 2001; Kumpulainen, Byman, Renlund, & Wong, 2020; Leonardi, 2010). In the cultural sector, a growing interest in digital tools can be identified both inside (e.g. in museums) and in nature. The expanded use of smartphones and other mobile technology has thus paved the way for including the leisure-like, direct experiences of on-site locations and exhibitions (Møller, Olafsson, Jensen & Kanstrup, 2020).

The relation between play and learning has long been a topic of research interest. Research on play and cognitive development has been strongly influenced by Piaget's (1962) constructivism theory that views play as a learning process through which children develop their cognitive skills. Another influence is Vygotsky's (1967) socio-cultural approach under which play is a social symbolic activity through which children learn and develop (Nicolopoulou, 1993). Play practices can therefore be seen as a fundamental part of our existence, as something that constitutes us as humans (Huizinga, 1949). At the neural level, pleasurable learning processes are more likely to be retained and consolidated as memories than neutral processes. Accordingly, activities that endorse

play and learning elements simultaneously are likely to be more memorable than those that do not. Although play and learning can happen in isolation, research suggests that social interactions enhance both the pleasure and the understanding of those activities (Zosh et al., 2017).

In this study, we discuss the use of mobile technology to motivate children to experience nature and seek knowledge about cultural history outdoors. Children are increasingly at risk of losing contact with nature – a development termed “the extinction of experience” (e.g. Soga & Gaston, 2016). This condition has been linked to children’s reduced physical and mental wellbeing, and difficulties engaging in environmental problem solving (e.g. Hughes et al., 2019). Thus, how can we motivate children to enjoy experiences in the natural environment that enhance their closeness to nature (e.g. Carlone et al., 2015; Chawla, 2007; Hicks, 2018)? Skar et al. argue that newer forms of children’s nature activities often are planned by adults whereas space for free play in nature supports a freer relational interaction with nature and provides opportunities for younger children to inhabit spaces themselves, thus creating embodied, social and affective experiences (Skar, Gundersen, & O’Brien, 2016, p. 529). For school-age children, learning to care for the environment by being immersed in nature is also likely to depend on playful adult-planned participatory activities. Crudely put, if children have few experiences with nature and therefore may be lacking a sense of purpose, they are more likely to engage in nature experiences if the activities involved are socially framed. Put differently, nature experiences become more meaningful if they are socially engaging and valued by peers (Carlone et al., 2015; Kalland, Sejersen, & Broch, 2005).

A new way to engage in nature-based playful activities with peers is presented by contemporary app technologies designed to work outdoors. App-based activities have the potential to engage users in participatory, creative and interactive processes. However, the unfolding of this potential depends on factors that tend to expose themselves predominantly in use (Collins et al., 2017), including the particular functionality of the app, match between user expectations and perceived usability, design and technological limitations. Further, the intent of app-developers may not always capture the actual practices and interactive bodily micro-processes pertaining to the use of particular apps (Schilhab & Esbensen, 2021). All these factors influence the extent to which the app is used successfully (Schilhab, Esbensen, & Crety, 2022). In this study, we examine the potential to combine mobile technology and a natural learning environment to enhance interaction in nature. We base our analysis on a Danish app called *Tidslommen* (The Pocket of Time). The app, which is presented in more detail below, was developed by Museum Vestsjælland, a collaboration between a group of natural history museums in Denmark, as a communication and entertainment tool for both families and schools with focus on children between 10 and 12 years. *Tidslommen* contains both audio and video guides and augmented reality (AR) with play elements, which can be activated when present at a specific geographical location. Using the walkthrough method and an ethnography approach, we explore media–bodily interactions with the app at four selected sites. Based on our experience with the app, we discuss how the interrelations among technology, place and peers change the experience of the situation and location as well as the possibilities for play and participation. We focus on the didactic choices in relation to the affordances of the technology, character of participatory activities and bodily interactions in nature guided by the app. Our overall research question is as follows: What is the potential for combining mobile technology and a natural learning environment to enhance interaction in nature?

## TECHNOLOGY, PARTICIPATION AND BODILY INTERACTION IN NATURE

This section provides the theoretical foundation for the intersection between mobile technology and natural learning environments. We draw on media theory related to participation and

affordance, play theory and theory on experiences with learning in nature to discuss the potential for using apps in situated learning.

### **Media: affordances and participation**

Different media, no matter their intended use, hold different affordances and thus allow for different interactions and activities. The concept of affordances derives from animals' interaction with their surroundings: "The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or evil" (Gibson, 1979, p. 127; author's italics). Gibson emphasises that the affordances of the environment (e.g. water) constitute a walkable surface for small animals but not for larger animals. In other words, the material is the same no matter who perceives it, but the affordances of the material are not. Affordances are thus related to both context and skills/purpose.

Gibson's concept of affordances has been central to the design and understanding of objects and technology (Norman, 1990). All media hold specific affordances, which allow for different activities and interactions. However, different media formats offer different possibilities and cause different limitations. Not all media can be used in the same way and not everybody uses the same media in the same way (Hutchby, 2001). A central feature of new digital technologies is interactivity. Digital media both offer and demand some kind of interaction. We must press buttons and swipe screens to use them. However, digital media also support our participation and interaction with each other. Such a participatory culture has low barriers to artistic expression and civic engagement, offers strong support to creating and sharing and provides social connections among users (Jenkins et al., 2006). Central to this perspective is the different forms of actions made available by the media, such as creating and sharing content with the potential for learning and generating knowledge.

### **Play theory**

The conceptualisation of play has developed during recent decades and is now not only perceived as something related to children. Today, play is connected to creativity, innovation, learning and aesthetics (Karoff, 2013b). The Dutch scholar Johan Huizinga defines play as a voluntary activity through which we create cultural meaning. Play is thus more a way of life than an activity. The purpose of play is play itself (Huizinga, 1949). In recent years, there has been a growing tendency to use play elements to optimise different aspects of life such as work processes and educational settings. On the one hand, this instrumentalisation of play can be seen as a dilution of play. On the other hand, it shows a growing acknowledgement of the power of play. Using elements of play in education demands a more inclusive approach to education since play is only possible as a voluntary participatory activity.

The Danish play researcher Helle Skovbjerg Karoff has developed three perspectives of play: play moods, play practices and play media. Play moods describe the way of being in play. Drawing on Heidegger's philosophy of mood and concept of *Dasein*, she defines mood as "a non-specific way of being where you are tuned in to the world openly so that meaning can be produced" (Karoff, 2013a, p. 83). The doings of play are related to play practices. As we play, we agree on rules, roles and framing and create a "common" play practice (Karoff, 2013a). Commonness refers to activities that we share socially and that make sense to everybody involved. Finally, play activities often involve different kinds of tools, toys, objects and media. The concept of play media is understood as the interrelations among meaning, practice and the participants. This conceptualisation builds on Heidegger's concept of *Zeug*, which translates as "tool" or "equipment". According to Heidegger, the meaning of a tool only appears when we use it. Applied to play, it is not important what kinds of media or tools we use, but *how* we use them and in *what context*. In the context of an app, elements of play are closely related to learning. The play media (the app) is not a neutral toy, but rather designed by adults for learning and acquiring knowledge.

***Learning in nature***

The extensive use of digital technologies for learning, information seeking, social networking and consuming entertainment inevitably results in fewer outdoor experiences among children and young people (e.g. Larson, Szczytko, Bowers, Stephens, Stevenson, & Floyd, 2019). Hence, direct experiences with the environment that encourage free-play opportunities and associated bodily interactions and learning are dwindling (e.g. Driessnack, 2009). However, this tendency is strengthened by other factors such as increased traffic, which prevents children from using self-sustained transportation to school (e.g. Huertas-Delgado et al., 2017). Similarly, our increasingly institutionalised leisure time leaves fewer opportunities for spontaneous nature-based bodily activities (e.g. Skar et al., 2016).

Children's decreased familiarity with nature is highly problematic since raising children's understanding of our dependence on the natural environment is urgent due to the global challenges facing modern society (Chawla, 2007). Although the increased use of technology is partly responsible for the decline in children's spontaneous contact with nature, this trend may not be set in stone (Schilhab, Stevenson, & Bentsen, 2018). Due to its wide-ranging functionality as described above (e.g. sustaining social contact, consuming entertainment, and learning), mobile technology is unlikely to be used to redirect the current course. The project Natural Technology explores the extent to which children's use of mobile technology can enhance their interest, participation, and bodily interactions in nature experiences (Schilhab & Esbensen, 2021; Schilhab et al., 2020). The results of the project suggest that children and young people unfamiliar with natural settings can be encouraged to participate in nature-based activities. For these children, activities mediated by mobile technology use are immediately recognisable as meaningful and appealing. In this study, we explore the practices and bodily micro-processes surrounding the use of an app, *Tidslommen*.

**THE CASE OF *TIDSLOMMEN***

The development and technological possibilities of apps to be used in nature are embryonic and developing rapidly. Further, given the infrastructure around smartphones, which are also developing rapidly (e.g. Internet connectivity, GPS connection, speed and storage capacity, camera functionalities), it is taking time to explore the potential of these media (cf. Brown, 2000). A variety of stakeholders are continuously experimenting with new features, conditions and creative ideas for how apps can influence humans' experiences. One such stakeholder is museums, which are exploring new ways of communicating, especially with children and young people.

Next, we present both the methodology and the app *Tidslommen* in detail as well as the four locations chosen as our case.

***Background and methodology***

This study originates from the authors' curiosity and desire to explore a pioneering concept in the field of nature apps for children and young people. All three authors have a common interest in how young people and media interact in nature experiences. The first author researches the use of media as part of a participation culture with a focus on how the media are interconnected with children's everyday lives, such as in connection to the use of digital media to enhance children's reading habits and culture (Balling, 2017). She mostly uses qualitative methods (e.g. interviews). The last two authors draw on knowledge from the Danish project Natural Technology in which they are exploring how smart technology use influences children and young people's nature experiences (Esbensen, 2020; Schilhab, 2021; Schilhab & Esbensen, 2019, 2021; Schilhab, Esbensen, & Nielsen, 2020). Natural Technology combines ethnographic and cognitive methods to explore how and why nature apps are developed and how they are used in practice in various outdoor settings.

We have studied the development of *Tidsloommen* as well as other nature apps over time, drawing on digital ethnography (Kaur-Gill & Dutta, 2017) to understand how developers navigate this rising field and explore the new possibilities within it. Investigating how an app works entails what Burrell (2017) calls “small-scale media-body interactions” consisting of swipes and scrolls between a user and the given technology. When observing phone users from afar, it is a challenge to follow a specific screen-based activity (Pink, Sinanan, Hjorth, & Horst, 2016) unless the ethnographer chooses to adopt the shadowing method (Czarniawska, 2014). Under this method, researchers literally put their heads together with the player and ask the player to play for the informant. Thus, the naturalness of the activity as well as social aspects (e.g. playing with one’s friends) can be a barrier, especially when the app is to be used while moving outdoors. In much research on apps, such as gay men using dating apps and women using menstruating tracking apps (e.g. Light, Burgess, & Duguay, 2016), ethnographers share the condition that users use the apps repeatedly for a period of time. However, as the format of a museum app for children does not lend itself to users’ repeated use, it must be designed in a way that newcomers can easily try it, which affects the possibilities for observing and interviewing users.

Møller and Robards term activities such as reading the app’s interface, following stories, answering questions and searching the location as “narratively entangled with the embodied knowledge that the researcher enters with and the sequential flow through which his or her body walks through and explores the app” (2019, p. 102). Therefore, we must test the app by engaging in bodily and sensory experiences ourselves to explore how the app framework and structure work when visiting a museum.

Thus, we used the walkthrough method, which is tailored to studying apps (Møller & Robards, 2019). This method examines the app at different levels, paying attention to the affordances, materiality and experience of its expected use. It involves “the researcher examining what the app contributes to users’ interaction with it” (Light et al., 2016, p. 888). The first part of the method examines the app’s vision, operating model and governance, while the second part involves the technical walkthrough. Since the method was developed to establish commercial global apps such as Facebook, examining the socioeconomic and cultural aspects of apps is crucial. In relation to *Tidsloommen*, this part of the examination consisted of us installing the app, studying the background material (text and video) made available by the museum (Museum Vestsjælland, 2021), trying out the possibilities available on the app when not at the location and choosing which places to explore. The technical walkthrough involved us, as researchers, engaging with the app’s interface, functions and features (e.g. pressing buttons) to “assume a user’s position while applying an analytic eye to the process” (Light et al., 2016, p. 891).

The walkthrough method focuses on the technology and its usability rather than on the surroundings. Since *Tidsloommen* is designed to be used while moving at a location, we combined the walkthrough method with sensory ethnography, which pays attention to knowledge not accessible through observations and interviews, but allows us “to understand and engage with other people’s worlds through sharing activities, practices and inviting new forms of expression” (Pink, 2009, p. 6). This approach allowed us to go beyond the mere role of observer and study how the app works in natural surroundings, using our own bodies as tools, and pay reflexive attention to the sensory experience throughout the walkthrough. Although we were not the intended target group and lacked the expected cultural learning processes of pre-teens and teenagers with technology-based play media, our intention was to position ourselves in the place of the adult (teacher or parent).

### *The app*

The app is based on GPS-related stories only available when the visitor accesses the app at the specific location (except for teasers to the activities, which can be accessed at home). It allows users to orient themselves on a map using a button, which moves the map to the location of the user. It contains both audio and video guides and AR with game elements, which can be activated when present at a geographical location of historical relevance. The app allows small museums and visitor centres to communicate at unmanned places and in nature, where communication would otherwise be difficult. In summer 2021, the app contained 27 locations, the majority of which contained video-led walks with stories and information related to the location (the app is continuously being developed to increase the number of locations and embedded information). A handful of locations contain narrative videos or games with AR and one contains virtual reality (VR). The main target group is children between 10 and 12 years who visit the locations with their schools or parents. The app is free and available from both the App Store and Google Play (<https://vestmuseum.dk/tidslommen/>).

In summer 2021, we conducted three fieldtrips to four locations (see below) to explore the app's functions and content. We selected the locations based on the types of content in the app and this allowed us to consider both the more traditional locations with video guides and the more advanced ones that use both AR and VR. Although the four locations constituted only a small proportion of the total number of locations, they covered the central elements of the app. We met in the morning, drove together to the museum locations and tried out the app as any newcomer would. We spent approximately an hour at every site carrying out the activities using the app, gathering field notes in the form of video material, photos and written notes and discussing the framing and activities and physical movement the app encouraged us to do. The locations of the fieldtrips are below.

*Kongeriget's vugge* (The Cradle of the Kingdom) is where the first Danish kings, the famous Skjoldungerne Vikings, lived. It is located in the area surrounding Lejre Museum. The ruins of Denmark's largest royal hall from the Viking Age can be found close to the museum. Several burial areas known as stone ships are also located there. The app offers video guides with information on the different stations, which can be activated as one walks around the location.

*Solens magt* (The Power of the Sun) is located at the end of a long bumpy road that leads visitors to Trundholm Mose, the marsh where Solvognen (The Sun Chariot), a bronze figure of a horse on a wagon carrying a golden sun disc, was sacrificed to the gods. The figure, found in 1902, is recognised as one of the most important discoveries from the Early Bronze Age. The app at the location provides two tracks: a quiz with five questions along the route and an AR game in which users must help the character, Pil, a young girl who is apprenticing as a sun priestess and learns about the rituals connected to worshipping the sun. The two tracks are not interconnected, as participants can complete one without completing the other.

*En kirke brænder/Følg historien om Erik* (A Church on Fire/The Story of Erik), an authentic reconstruction of the fire of St. Bendt's Church in 1806, can be experienced using VR at the local museum in Ringsted, where the church is located. In the grounds surrounding the church, users can activate three short videos telling the story of a boy, Erik, who joins the convent. The video bites, which are narrated by children playing the roles of the parents, the monks and the boy, explain what it was like being a child in the Middle Ages. The app also presents an AR illustration of the burning of the church.

Finally, *Kongens ven* (The Friend of the King) is situated in the ruins of a monastery in Antvorskov. Here, the app provides an AR game that allows users to take part in a real drama and help cure the king's mortally wounded friend. It contains both play elements in which users must help the local monk collect healing herbs and other elements providing information about life in the monastery when users locate spots in the ruins.

## POSSIBILITIES WITH TECHNOLOGY IN NATURE: ANALYSIS OF THE CASE

In the following, we analyse and discuss our experiences of using the app at the four locations, with a focus on technology, participation and bodily interactions in nature. The use of technology in nature is always challenged by issues related to sun and rain as well as the availability of suitable hardware. Not every child will have access to a smartphone of the model and generation required to run the app. In this study, we disregard these issues and focus on the functionality and possibilities of the app.

### *The affordances of an app*

In all four of the locations tested in this study, the app contains short video talks presented by museum professionals. This element contains little interaction and demands no involvement other than viewing and listening. Still, moving the communication from an adult presenting at the location to the smartphone allows participants to activate the video guide at different times and thus individualise and make the experience flexible.

Surrounding St. Bendt's Church (*En kirke brænder/Følg historien om Erik*), the app shows several spots that can be activated by physically approaching the specific location on the map and touching the screen. Three of the spots have numbers indicating the starting point. The first has a video narrator telling a short story of the church. In the second, we see a short video of the story of Erik, a small boy taken to the convent by his parents. A monk greets him and invites him into the church. The final video shows Erik teasing the monk by hiding in the cavernous building. The videos use child actors to tell the story of childhood in the Middle Ages, but do not allow for any interaction.

Other spots in the church surroundings provide insights into different aspects of the history of the church and monastery (e.g. the church fire). When activated, the app shows an AR reconstruction of the fire. When moving the phone around, the photo of the church is supposed to follow the illustration of the fire. However, the screen text on one of our phones was mirrored and the screen was empty on another. For us, as newcomers, the different spots at the location seemed fragmented and dislocated, making it hard to understand the supposed order of the story and keep motivation and engagement intact.

Some locations such as *Kongens ven* offer quizzes, where users must interact by answering written questions or questions asked by the AR avatar. When arriving at the ruins, we activated the app and an AR narrator appeared. She introduced the ruins and invited us to answer a couple of questions by pressing the touchscreen (e.g. "Do you think the monks were rich or poor?"). We began to explore what happened if we answered differently. It turned out that she responded in the same way no matter our answer. At some locations, it was possible to answer the questions in a random order; at others, users had to follow the order embedded in the narrative.

Such AR elements require users to actively participate by searching the location to find the right spot, after which an element appears on the screen. At *Solens magt*, for example, participants must help Pil by swiping the screen to sow and reap a cornfield before users can learn about the sun rituals. A crucial item in the ritual is the Sun Chariot. Pil drops it the first time she must perform the ritual on her own, and in one of the play elements, we could help her recover the pieces and join them to complete the ritual and thus restore the balance of the universe. To find the elements, we had to walk around the location and pay attention to both the rhythm of a drum played as a soundtrack in the game and the intensity of the buzzing of the smartphone. Here, the technological possibilities built into the phone (GPS connected to sound and movements) intensified the quest and invited participation.



Similar affordances were used in *Kongens ven*. As we approached the ruins, the avatar appeared, telling us about the king's sick friend and monks in charge of collecting herbs. As with Pil, we had to locate the herbs, but without help from the affordances of the smartphone (sounds and buzzing), which made the task harder. We had to find three herbs unsuitable for creating medicine to allow the monk to tell us about these herbs, before selecting the right ones. After collecting the herbs, we were invited to help the monk further. The voice of the avatar told us to match a sketch of a piece of the ruins that appeared on the screen. Using the AR technology, we again had to enter the ruins to find the right spot. This element combining sketches and AR was used several times in the ruins.

In summary, the app uses text, sounds, images and vibrations and requires participants to swipe, press and move the camera phone around to locate items and buildings.

### ***Participation and play among peers***

The affordances and narratives offered by the app can be used individually or in small groups. Hence, the app allows for more flexible interaction with the cultural site and surroundings than a physical presentation by a museum professional. For instance, visitors can use the activity whenever suitable (even outside opening hours), the videos and games can be repeated if needed and teachers and parents can freely add information. Therefore, this flexibility contextualises knowledge during the activity and allows adjustments to suit the target group.

The app includes play elements in which users must choose a spot on the screen (they are not visible at the location) and find the physical location at which the spot can be activated by bodily interaction with the app as well as with the environment. This both improves navigation skills and the ability to be aware of the location while following the dot on the screen. These elements of the app may also improve participation and collaboration, as one group can show other groups how the app functions, how the game elements are solved and where to go (unless teachers facilitate the activities in another way). By contrast, the use of GPS systems and potential lack of signal coverage could lead teams to blindly follow their classmates. Further, the quest to match the location of the phone to a physical place to activate the spot would be difficult when a number of people are sharing one phone. Hence, it would be difficult for the group members not holding the phone to follow what is happening visually and auditorily on the screen. Thus, the holder of the phone would need to communicate the actions on the screen to their group members for all to keep up with what is happening. Consequently, the activities that include a story to be followed could be a challenge for large groups. Further, if users wish a closer connection to the activity, they would need to start the activity from the beginning. Thus, for these types of activities, teachers must decide a suitable group size for using phone-mediated communication on the move.

The AR elements in the app create an atmosphere of intertwining the natural surroundings and technology. At each location, seeing the surroundings on the phone in real time combined with the narrator appearing on the screen creates engagement. The combination of location and technology creates a feeling of being in the middle of the story. The AR technology that uses the affordances of the camera phone also allows peers to enter the screen. Consequently, users can jump in and be part of the story, which takes place on other people's screens. Although an unintended activity, it nevertheless invites play among participants. Hence, on the one hand, the app functions as a source of knowledge and information and supports interaction; on the other hand, it can be integrated as an add-on to play activities among groups of children.

### ***Bodily interactions in nature***

The need to be at a location to activate the functionalities of the app triggers experiences of nature and physical activities for the user. On the visits to *En kirke brænder* and *Kongens ven*, the authors walked approximately 1000 meters to locate the spots and perform the tasks. To take part in the



unfolding of scenes such as at *En kirke brænder*, users must orient themselves in the environment. The unfolding of the storyline spot by spot is paralleled physically by moving from spot to spot in the location. Hence, the story is bodily internalised by the steps taken and such orienteering. The spot designated to the actual burning of the church invites visitors to turn around multiple times in embodied search for the overlap between the existing buildings and those projected by the screen. The use of AR encourages visitors to experience the location from different angles.

At *Kongeriget's vugge*, visitors are guided by both videos and signs around the location, allowing them to grasp the grandiosity of the kingdom by walking considerable distances and seeing the reconstruction of formerly important buildings of the time in hayfields. Likewise, one is bodily reminded of the physical feel of the monastery at *Kongens ven* by interacting with the ruins. Visitors are invited to carefully climb the ruins to solve tasks. The intense search for figures mirrored on the screen forces visitors around the ruins, walking up and down the stairs, around corners and onto plateaus, which provides a realistic impression of how the monks once moved around the building.

Using the location as the scene for historical events takes advantage of the weather conditions, terrain and wildlife. The spots are not located along a neat path; rather, the search for more information takes visitors through rough and damp areas. As the walks happen outdoors, the physical presence of nature in the form of wind, precipitation, temperature changes, wildlife and the view of clouds on the horizon become the indispensable embodied backdrop for the narrative on the screen. However, the app's amalgamation of contemporary stimuli with imagined events did not disrupt the narrative. The concurrent awareness of the present invoked by the buzzing of life added to conceptualising the historical narrative. Literally, we simultaneously stood with one foot in history corroborated by the storyline afforded by the app and with one foot in our time. When we swapped between them, we shifted the perspective from which we could understand them.

Using the narrative of *Kongens ven* as an example, it became clear that *Tidslommen* has been designed to avoid the screen becoming the sole focus of attention. The task of finding window frames that align with the images drawn on the screen enhances users' phenomenological and bodily awareness of their surroundings. They must look at the building from different perspectives and move to find the fragments that match the sketch on the screen. Such a task cannot be solved unless visitors focus more on the actual building than on the screen. The app scans the contours of the window when it is found, allowing players to solve the task and continue. Hence, the functionality of the app means visitors primarily attend to the environment and consider the sketch to be only that.

When the tasks have been completed, a video presentation featuring a museum guide pops up, providing historical facts about the site in a traditional storytelling style. Compared with the abovementioned tasks, we found the traditional way of sharing knowledge more attention-grabbing because being instructed to look around while listening seems counterproductive to understanding the narrative shared by the guide.

## DISCUSSION

Our experience of *Tidslommen* reveals that using technology in relation to natural history sites both supports learning and encourages play. The app allows for a tailored approach to the location and information embedded in the app. Users thus play a more active role than being spectators in a traditional analogue learning situation (Jenkins et al., 2006). The play elements of the app also raise the interaction between peers, inviting collaboration. The affordances of the app (Hutchby, 2001; Leonardi, 2010) restrict the experiences by forcing participants to act in specific ways and move to specific spots, but also make possible different forms of interactions and movements. Thus, the rules of the play practice, while being defined by the technology to some extent, still allow for the arising of "commonness" (Karoff, 2013a). Further, the app functions as play media (Karoff, 2013a, 2013b)

by creating a playful atmosphere and allowing participants to create meaning through practice. Although play is considered to be a joyful voluntary activity (Huizinga, 1949) and the activities related to the app may be less voluntary since the target group (children between 10 and 12 years) is there with their families or schools, using the app has a more playful atmosphere in the learning environment and invites a different approach to learning about history and the specific location. For example, when searching for spots at *En kirke brænder*, visitors are led around the carefully tended churchyard via narrow paths and nooks and crannies, which invites exploration not explicitly intended by the app-scheduled plan.

Simultaneously, app-supported interactive learning includes multimodal sensorimotor experiences such as touch, smell, sound and physical action, which become central parts of the meaning-making (Hutchins, 2005; Kirsh, 2010). Clements (2000) refers to knowledge based on embodied and conceptual processes as “sensory-concrete” knowledge, which emerges from the association of sensory material to thought processes when grasping an idea. In the present case, the app guides users to engage in multimodal sensorimotor experiences both with the environment and with the media. The technology provides immediate feedback through app–user conversations (e.g. images of the relevant herbs appear on the screen at *Kongens ven*), driving the narrative forwards. Hence, the app-based activity facilitates conceptual learning and memorisation processes because of the bodily engagement involved in operating the device (e.g. Schilhab & Esbensen, 2021). The app-supported walk from spot to spot also seems crucial to the sense of participation in the narrative unfolding over time.

However, the perception of analogue storytelling as if users are situated within the historical scene entails some fragmented communication. While the short interactions with the environment may be experientially rich, they are also less reflective and therefore less conceptually fulfilling due to being interactive. If the engaging embodied and interactive fragments are not nested within a descriptive wrapping to perspectivise the experiences, the explicit knowledge gain becomes even more negligible. The long-term effects of the communication are enhanced when the bodily and phenomenally rich encounters are associated with and contribute to understanding propositional knowledge (e.g. Schilhab, 2011 2015a; b, 2017a;b, 2018).

The need for perspectivation also explains why we suggest that children should depend on the teacher, parent or museum guide to frame the interactions and ensure they make sense. For example, such framing can occur when teachers prepare students for a fieldtrip and continue to facilitate systematic working with themes in reflective tasks when back in class. At the location, the question of framing is often related to the stimulation of students’ curiosity, which is then satisfied in spontaneous conversations, leading to learning. Hence, the mere interaction with the app on site is insufficient to create a lasting impression about the historical event.

## CONCLUSION

Returning to our research question, we found that using mobile technology to communicate in museums can enhance and encourage interest in cultural history sites. Although we were not the intended target group, our interest in and knowledge about the location and its history increased as the app forced us to move around the locations.

The app provides for a flexible learning environment in which users can act as participants and learning peers as opposed to playing a simple receiving role. It encourages collaboration and dialogue between users to solve the tasks embedded in the narratives. In particular, the AR elements demand interaction and movement because participants must move around the entire location. In most locations, the app requires participants to walk around, go off the beaten track and spend a considerable amount of time at the location to “complete” the game/narrative. Thus, the

app connects the location (the nature) with the cultural history as well as combines the present and past and the analogue and digital approaches and perceptions. Thus, it links the bodily and sensory experience of the natural surroundings with the multimodal sensory experience of the media.

While the app has great potential considering the interactions and experiences with nature it offers, it also has room for improvement. First, the on-site visits demand framing and facilitating by the teacher to be more than an exciting day out of school. The teacher must perform background research on the app and even try to visit the locations beforehand. Thus, the visits demand that teachers are more prepared than when visiting a traditional museum where professionals frame the history. Without such framing, the activities risk becoming fragmented and the learning outcomes could be somewhat shallow. The string of intense contact with selected parts of the story may leave visitors with a sense of a narrative lacking closure. As in real life, the significance of particular events may be less well understood while they unfold. It is more often only in retrospect that the meaning starts to evolve. Hence, it is worth considering whether the effect of the interactive communication that demands a full bodily interaction could be strengthened if presented together with a careful overview.

In summary, this study points out the considerable potential for expanding museum communication through mobile technology. We acknowledge that *Tidslommen* is under development and has limited financial resources. We further acknowledge that our assumptions are based on our experiences and not those of the intended target group. Still, the app allows for a more playful, interactive and participatory approach, which aligns with the meaning-making process found in play culture. Further, it encourages both spending time and bodily interaction in nature. However, to substantiate the learning outcomes, the activities must be framed by an adult.

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