«We’re in the classroom, but we’re also in the museum at the same time! »

A qualitative study of the opportunities for learning with a telepresence robot in a natural science museum

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Abstract

Museums are considered cultural and educational institutions of significance in today's knowledge-based society (Falk & Dierking, 2000). Traditionally museums have by many been considered as "closed" institutions, for a cultural elite, but over the last decades this has changed, mainly driven by technological advancements (Roussou et. al., 2000). Novel technology and new platforms allow museums to communicate and express themselves in new ways, and technology such as virtual reality and video-conferencing has opened up for new groups to enter the museum. School field trips to museums have always been a part of the traditional museum, but have often been seen as irrelevant for curriculum, and hard to conduct and follow up due to structural challenges (DeWitt & Storksdieck, 2008). This study seek to explore and investigate the opportunities for using novel technology, in form of a telepresence robot, for learning in museums and bridging informal and formal learning institutions.

This study is conducted at Musée des Confluences in Lyon, France, and in a fifth grade classroom in France. From their classroom, 22 students divided into four groups, conducted a field trip to Musée des Confluences using a telepresence robot. Musée des Confluences is a natural science museum that opened in 2014, and includes a variety of species, technical development and pieces from world history dating back to the Big Bang in their exhibitions. This study takes place in their permanent exhibition *Origins: stories of the world*. The visit was designed based on projects the class was already working on, inputs from their teacher and inputs from the museum educators. Each group was given a worksheet with three tasks to complete, and in addition they had time to freely explore the exhibition with the robot. A guide from the museum was following the robot, to answer any question the students had.

My aim for this study was to investigate *the opportunities for learning and meaning making with a telepresence robot in a natural science museum*. I seek to explore the opportunities of using such technology for learning in museums, and how this can contribute to meaningful experiences for students in a classroom. My work with this study is grounded in a sociocultural and dialogical perspective on learning (Vygotsky, 1978; Dysthe, Bernhardt & Esbjørn, 2012). From a sociocultural perspective, interactions with other and with mediated

artefacts are what drive learning and human development forward. We learn through others, through artefacts and dialogue (Dysthe, Bernhardt & Esbjørn, 2012). Therefore, interactions become the main focus when investigating learning opportunities in this study. To investigate this I ask two research questions: "*How does a telepresence robot mediate learning and interactions in a museum context?"* and "*In which way do these interactions enhance learning and understanding?".* Grounded in my research questions, supported by my theoretical stance and previous findings on the field, I aim to understand how interactions in the student groups and artefacts mediated by the robot can serve as foundation for learning experiences in museums.

My data collection consists of observations and audio recordings from each of the four groups of students. These audio recordings are transcribed, and serve as my main source of data in my analytical approach. As supplementary data I have observations and field notes from the classroom when conducting the visit, from preparations with the teacher, and from the debriefing session held two weeks after the visit, an interview with museum-guide, and questionnaires filled out by the students post-visit. Audio recordings are analysed using the method of interaction analysis, to better understand and investigate the interactions taking place during the museum visit (Jordan & Henderson, 1995).

I have identified three areas I consider of importance for the students learning and meaning making experience when visiting the museum with a telepresence robot. These findings are *worksheet design, social setting,* and *navigating the robot*. I found that a strict worksheet design may limit the students in their exploration of the museum, and decrease motivation and engagement (DeWitt & Storksdieck, 2008). Worksheets are often used as the primary tool when conducting field trips (DeWitt & Storksdieck, 2008), and the design and structure of these is of significance for the students learning experience. My second finding is that the social setting is crucial for learning. In this study the students had to master being in a group, to collaborate and contribute with their previous knowledge and statements to achieve a common goal. The task required them to communicate with each other and with the museum guide through the robot to solve their worksheet tasks. The groups took on this common identity (Leinhardt & Knutson, 2004) by asking questions such as "what are *we* interested in" and "where do *we* go now", emphasizing the role of the group as a whole. However, my findings show that especially one group struggled to master the social context. There is a risk

that conducting the visit put them “on display”. This finding in some of the groups seems linked to research showing that if something is “too novel” this may be of hindrance instead of serving as engaging (Pujol-Tost, 2011). My final finding regards navigation of the robot. The field trip with the telepresence robot is designed as a collaborative effort, and requires the students to communicate and work as a team to solve their task. Excerpts from my audio recordings show that the students take on navigation as a collaborative effort, discussing where to go, and how to position the robot so that everyone in the group can see in the museum. I consider the navigation to be a fun, engaging and meaning making activity on its own, fostering collaborative skills that are essential for learning (Soller et. al., 2005).

In my study I have investigated how a telepresence robot can mediate learning in a museum for a group of students, and how interactions and artefacts impact the students learning outcome. I found that there is a link between design of the worksheet and tasks, social context, and the navigation of the robot. These are all factors mediating and framing the learning activity of visiting a museum with a telepresence robot.

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Working with this thesis has taught me a lot about myself, my capabilities and has provided me with an insight into the pedagogical world I will bring with me the rest of my life. Completing this thesis has resulted in a strong sense of achievement, and I consider my structural work as a valuable learning experience that will help me in my future professional and personal life.

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Table of Contents

1 Introduction

In today's knowledge- based society and economy, knowledge and meaning making more than ever before become the key to social and economic well-being (Falk & Dierking, 2000). Learning in the 21st century is not limited to the traditional school-setting. Today learning is considered a dynamic and complex process, taking place in our everyday life, through interactions with others, new experiences and meeting with new areas (Falk & Dierking, 2000). Learning today takes place both in institutions that are traditionally considered learning areas, but also in new forms and on new arenas, often facilitated by technology.

Museums are considered arenas for learning and exploring that have social and cultural significance (DeWitt & Storksdieck, 2008; Leinhardt & Knutson, 2004). Over the last decades, there has been a change in the way museums act and interact with their visitors and local communities (Roussou et. al., 2000). This is even referred to as a shift of paradigm in the way we consider museums as institutions (Roussou et. al., 2000) and is mainly driven by the rapid advancements in the development of technology. Novel technology allows for museums to communicate and be accessible on new platforms, thus reaching a broader audience and even new groups that are not traditionally considered primary visitors (Roussou et. al., 2000). No doubt that access to museum exhibitions have been limited to physical presence in the museum, thus limiting its reaching point for the public. Through virtual reality, digital exhibitions, video conferencing and lately also museum robotics, museums are challenging the traditional way of considering and conducting museum visits (Roussou et. al., 2000). This allow for new opportunities and experiences for groups that may have had limited access in the past, such as school-classes. With new technology, whole classes can take virtual field-trips, gather information and explore museum exhibitions around the world, without leaving the classroom. In the latest years, some museums around the world have incorporated telepresence-robots into their exhibitions, providing the visitor with a real-time, and eyes-on experience of their artefacts (Ramon-Vigo et. al., 2016). Several researchers have argued that museum visits should, in a greater extent, be used as a supplement to classroom learning (Bamberger & Tal, 2007) and that school curriculum should serve as a base when conducting such visits (DeWitt & Storksdieck, 2008). Development of interactive communication technology (ICT) allows for experiences that connect formal school-learning with informal learning institutions such as museums, and facilitate new learning experiences

for both schools and museums. Such experiences have proven to affect both students' motivation, and engagement as well as academic and social skills (DeWitt & Storksdieck, 2008).

1.1 Contextualisation and limitations of this study

My study takes place in Musée des Confluences, a natural science history museum in Lyon, France, and in a fifth grade classroom at a French primary school. The museum has both permanent and temporary exhibitions, including a big collection of species from around the world, dinosaurs and fossils. The museum opened in 2014, and the exhibitions are framed by interactive technology such as touch screens, and audio- and video- information. The museum conducts school-visits and other group-tours on a regular basis. During the inauguration in 2014 the museum used telepresence robots, and invited hospitalized children to join them during the evening. The background for this study is to explore how the museum can take these telepresence-robots into their everyday use, and facilitate for museum visits and learning experiences in new ways. A telepresence robot allow the remote user to control a robotic avatar, exploring the environment and interacting with people in a more natural way, than for example through video conferencing (Roussou et. al., 2000). Telepresence robots allows not only the user to be virtually present at remote places, but also has the mobility and the ability to better interact with other people, as if the remote user were really present in the remote environment (Ramon-Vigo et. al., 2016). Several museums around the world have already been using such technology for a while, mainly for people with physical disabilities that hinder them from visiting the museum. In my study I aim to explore how a telepresence robot can be used for connecting school and museum as learning settings. Many schools struggle to conduct field trips, and are often limited by both financial and organisational struggles (DeWitt & Storksdieck, 2008). In addition, both museum and school as institutions seem to differ in goals for conducting such visit, thus not making it applicable for further work in a curriculum setting (DeWitt & Storksdieck, 2008). The aim of this study is therefore to investigate how telepresence robots can be used for creating and mediating meaningful learning experiences for students, including how to design for such visits and how to contextualize it so that it becomes a valuable experience for students, teachers and museum practitioners.

1.2 Research questions

In this study I seek to explore the "*opportunities for learning and meaning making with a telepresence robot in a natural science museum?"*. I aim to understand and define the role of the telepresence robot in this setting, and how the robot can contribute to meaningful learning experiences for students. Is it just going to be a fun experience, or can such event facilitate learning? And how do we assess such experience, in terms of learning outcomes for the students?

I have formulated two research questions for this thesis: "*How does a telepresence robot mediate learning and interactions in a museum context?"* and "*In which way do these interactions enhance learning and understanding?"*.

My study focuses on how navigating the robot affects the students, how they manage to collaborate in their groups, and how they choose to solve and balance all tasks they are given. I am also curious how they choose to use the museum guide, and how she takes on her role when she is guiding the students in a robot and not a group physically present.

1.3 Structure of thesis

This thesis is structured in main sections with associated subsections. Section Two is a review chapter, focusing on previous research and relevant literature on museum learning and field trips, technology enhanced learning and robotic technology in a museum context. The summary is a reflection on the literature, and how I will use this when analysing my data.

In Section Three I present my theoretical stance. This thesis is grounded in a sociocultural perspective on learning (Vygotsky, 1978). Sociocultural learning theory is first presented, and then related to a museum context. I also describe a dialogical perspective on learning in museums (Dysthe, Bernhardt & Esbjørn, 2012), and finally present a sociocultural model from Andersson & Jakobsson (2012) that will serve as a supplementary tool when analysing my data.

Section Four focus on my design, structure and method for conducting this research. In this section I present the context for conducting this study, and an overview on types of data and how these were collected and analysed. This section also contains a critical reflection on the validity and reliability of this study, and my role as a researcher.

Section Five is the analysis of my data. I start by giving a rich explanation of the whole 80 minutes visit conducted by the students. Then I present four excerpts from my data and analyse these separately. I summarise this section with key findings from all excerpts.

In Section Six I discuss my findings, and in Section Seven I put my findings in a greater context and propose suggestions for use and further research, before I sum up my findings and work with this thesis.

2 Relevant research on learning and use of technology in museums

In this chapter I will look at relevant research and earlier findings in the area of learning and the use of technology in museums. I start with a review on learning in museums, and the field trip as a learning activity. I will then account for technology enhanced learning and the development and use of virtual reality and finally look into the area of using robotic technology for learning in museums.

2.1 Learning in museums

All museums share a commitment to provide enjoyable experiences and learning opportunities through a broad specter of media-exhibitions, technological tools, educational programs and presentations through print and broadcast media, increasingly by distance learning through media such as the internet (Falk & Dierking, 2000). Large investments are made in developing exhibits, programs, books, and web-sites for the public, with the assumption and aim of contributing to new knowledge in the visitor. The question raised is, do people learn from museums?

In their research Falk & Dierking (2000) discuss how, and if learning occurs in museum, and why people choose to visit the museum. Traditionally, the learning that occurs in museum is referred to as informal learning (in contrast to formal learning in school), but Falk & Dierking (2000) argues for the use of *free choice learning*, as a replacement of the term. "Free choice learning tends to be non-linear, is personally motivated and involves considerable choice on the part of the learner as to what to learn, as well as where and when to participate in learning" (Falk & Dierking, 2000, p.7). This was considered an important factor when designing for the visit to Musée des Confluences with a robot. People come to museums to learn, find meaning and to find connections. This *free choice learning* from museums is linked to the daily learning experiences we get from watching TV, visiting cultural institutions, discussing with friends or surfing the internet (Falk & Dierking, 2000). In this study I seek to investigate how this can be combined with the school as a formal learning area. In recent museology- research there has been a discussion about a shift of paradigm in the way we consider museums (Dysthe, Bernhardt & Esbjørn, 2012; Andersson & Jakobsson,

2012). From considering the museum as a classical authoritative and formatting institution, where knowledge is distributed from the inside and out to the public, the public are more and more considered participants and co-constructors of the knowledge and experiences taking place in the museum (Dysthe, Bernhardt & Esbjørn, 2012; Kidd, 2014). This dynamic way of considering the learning process is highly influenced by, and adjusted to our time of living with digital tools, and this shift of paradigm explains how a study like the one conducted in this thesis has become a possibility. Falk & Dierking (2000), stating that people *do* learn from museums, problematize the method used to evaluate this learning process. Because learning from museums often is evaluated in a traditional school-model, considering the exhibition or museum-guide as a transmitter of knowledge, and the visitors as passive receivers, the learning is placed in a linear way of thinking about knowledge. This way of considering knowledge-integration does not quite work in a museum setting, and mostly not really in a school-setting either (Falk & Dierking, 2000). They argue for a contextual and holistic approach to learning in the museum setting, where learning is considered "a series of related and overlapping processes, appreciating that such systems can be difficult to make sense of because of their complexity and ephemeral nature" (Falk & Dierking, 2000, p.9). The research on learning in museums is relevant to address my research question "*What are the opportunities for learning with a telepresence robot in the museum?".* An understanding of the informal or *free-choice* learning that occurs in museums is necessary to ensure that I have a broad picture of the museum as a learning institution to analyse and discuss my data and findings in my study.

2.1.1 Field trip as a learning activity

Field trip related research from the 1970s to the 1990s contrasted out-of-school learning settings such as visiting museums, with in-school instruction. Most of this research focused on cognitive or conceptual outcomes and was based on the general premise that school field trips had to be able to compete with classroom instruction to show their educational worth (DeWitt & Storksdieck, 2008). There was common agreement that field trips may lead to some better learning outcomes than school-based instruction, but this was highly circumstantial (DeWitt & Storksdieck, 2008). Later, both teacher and museum- practitioners also tend to value the field trip as a social and affective experience for the students (Anderson, Kisiel, & Storksdieck, 2006; Storksdieck, Werner, & Kaul, 2006, in DeWitt & Storksdieck,

2008). They show an appreciation of the skills gained beyond conceptual knowledge, such as process skills or awareness of lifelong learning and community infrastructure (Storksdieck, Robbins, & Kreisman, 2007, in DeWitt & Storksdieck, 2008). Research indicates that both cognitive and conceptual skills, as well as social and affective skills, can all occur as the result of a field trip (DeWitt & Storksdieck, 2008). This learning is, however, influenced by a number of surrounding factors. These factors include the structure of the field trip, students prior knowledge, novelty of the setting, teacher's agenda for the trip, and preparation and follow-up activities for the trip (DeWitt & Storksdieck, 2009).

Considering a field trip not only as a space for gathering conceptual knowledge, but for developing affective and social skills, the field trip becomes valuable in own right, not just an extension of classroom teaching, but a valuable supplement for understanding and teaching curriculum and an excellent way of preparing students for future learning (DeWitt & Storksdieck, 2008). This broad way of thinking about learning corresponds with the view on learning in the 21st century (NOU 2015:8). It could even be argued that affective learning outcomes such as increased interest and motivation, curiosity or improved attitude towards a certain topic may be a more reasonable focus for field trips, since their short-term nature that may not be best suited to create cognitive and long-term effects (DeWitt & Storksdieck, 2008). However, both teachers and museum educators need to consider what can create and affect long-term cognitive learning. Research shows that even though museum educators are encouraged to follow curriculum and the teachers' agendas for the field trip, this can be challenging. First of all, because teachers tend to have several objectives for the trip on their agenda (DeWitt & Storksdieck, 2008), including both cognitive or curricular and affective goals.

Falk & Dierking (2000) argue for the social interaction that occurs during a field trip as an important feature. Research shows that students value these interactions (DeWitt & Storksdieck, 2008), and appreciate when the visit is not completely controlled by teachers' or the museums' agenda, leaving room for them to explore, discuss and discover from their own perspective (DeWitt & Storksdieck, 2008). This is important to consider when designing for, and planning a field trip, and these are factors that were taken into account when planning the visit with the telepresence robot in this study. For the students to have both affective and cognitive learning outcomes, the visit should be semi-structured, as in this study, where

students both have worksheet tasks to work on, and the opportunity of free-choice exploration of the exhibition. DeWitt & Storksdieck (2008) and Bamberger & Tal (2007) discuss the use and design of worksheets. Often used as a way of controlling the visit with too many, and too detailed questions, worksheets have an ambivalent role in museum learning, and even though they have shown to be effective for teaching cognitive skills, they can decrease students' motivation, curiosity and engagement when implemented too strictly (DeWitt & Storksdieck, 2008). Therefore, when designing worksheets, both teachers and museums need to consider both affective and cognitive skills as a whole, to create a field trip that enhances motivation, curiosity and cognitive and curriculum-based skills. The research on field trips is relevant for this study in the way that I consider the visit to the Musée des Confluences a novel way of conducting field trips, to combine informal and formal learning areas. The study was an out of school- setting, taking place in-school. The structure of the visit was also based on elements from the field-trip literature, being semi-structured and based around work-sheets.

2.2 Technology enhanced learning

Technology enhanced learning (TEL) is a term that has developed with the emerging technological trends and the use of technology for human learning. TEL covers the areas of computer-supported collaborative learning (CSCL), mobile learning, artificial intelligence and the use of technology in both informal and formal learning-environments for human learning (Balacheff, Ludvigsen, de Jong, Lazonder & Barnes, eds., 2009). Balacheff et. al. (2009) focus on five areas of research contributing to the development and understanding of the TEL-field, including; the design area, and its importance for the design and evolution of new learning activities, the computational area, representing what technology makes possible, the cognitive area, focusing on what one individual can learn under certain conditions and contexts, the social and cultural area and its importance for meaning-making and participation, and finally the epistemological area, and how the specificities of a certain domain impact the design and use of technologies. To understand that all these areas have an impact on how we take advantage of, and design for, the use of technology in varied learning environments is essential to optimize learners' interactions and experiences, and to use technology in an empowering way for learning (Balacheff et. al., 2009).

2.2.1 Computer supported collaborative learning

Computer supported collaborative learning (CSCL) often focus on distance education or e-learning. The experience with visiting the museum can be seen as both a way of distance education and e-learning, but maybe not in its traditional sense. However, I consider the key-points from research on this area to be relevant for this study, both for the collaborative group-work and computational-technological part of my study.

The development and adaption of network-based technologies in educational settings, occurring over the last decade, creates new possibilities to reach new learners, and to foster collaboration among these (Soller, Monés, Jermann & Muehlenbrock, 2005). CSCL aims at studying how people can learn together with the help of computational technology (Stahl, Koschmann & Suthers, 2006). However, understanding and measuring how (and if) learning occurs in a CSCL environment, why certain interactions and collaborative tasks are performed, or not performed, is based on a variety of factors. Students' prior knowledge, motivation, roles, language, behavior and group dynamic are all influential and important factors when evaluating such learning process (Soller et. al., 2005). A CSCL environment can be either completely online, such as an e-learning solution, or concerned with face to face collaboration. Computer support does not always take the form of an online communication medium, but may involve a simulation or a scientific model, or a shared interactive representation (Stahl, Koschmann & Suthers, 2006). In this study, the students are involved in both face to face interactions that require collaboration to solve interactions that can be considered a shared interactive representation. All interactions occurring at the same time, though conducted in the classroom, the visit to the museum took place in real-time, in a real-world, out of school -setting. The visit was mediated and supported through online computational and robotic technology, requiring students to interact with each other, with the technology, and with the exhibition and museum-staff, mediated both by humans and by technology.

2.2.2 Video conferencing

With the growing recognition that 21st century learning includes overlapping and continually changing societies of teachers, parents, students and informal educators such as museum educators, we are also presented with the challenge to transform 20th century educational

structures into successful 21st century learning communities (Barbanell, Newman & Falco, 2003). The core of such development lies in effective communication that contributes to the learning community. With the rapid technology, communication has taken new forms, and video conferencing is not a new phenomenon in museum settings. Use of interactive video-conference technologies has invited both regular visitors and school-classes into some of our most renowned museums around the world. In their research project VIEW Barbanell, Newman & Falco (2003) seeks to investigate how interactive video-conference technology can be used to transform existing methodologies into collaborative and interactive digital environments that extends beyond the classroom walls. The idea is that interactive video conferencing supports inquiry learning, collaboration and novel ways of presenting and working with curriculum (Barbanell, Newman & Falco, 2003). Through three conducted case studies, working with classrooms and museums in the USA, they found that the delivery of instruction through interactive technologies resulted in higher-level student learning and academic performance (Barbanell, Newman & Falco, 2003). Positive outcomes mentioned by the students were inquiry learning and the expansion of available resources and their use. This way of using interactive technology to restructure the classroom and classroom pedagogy to enhance learning, is essential to further develop 21st century learning and skills. In my study, the robot can be seen as interactive video conference technology taken one step further; allowing the pilot of the robot to be even more immersed in the experience it is to visit a museum exhibition, through self-controlled mobility. This technology blurs out the walls of the classroom, and can be considered valuable tools when transforming the traditional classroom into 21st century learning communities.

2.2.3 Virtual reality in museums

In their article from 2007, Pujol Tost and Economou discuss the entrance of virtual reality (VR) in museums. The new social, communicational and educational role that has been assigned to museums over the last three decades have led to current museographic trends advocating new and more experiential ways of presentation (Pujol Tost & Economou, 2007). The visit is understood as an emotional, physical and cognitive immersion in a social and multimedia environment with which visitors establish a dialectical relationship, and where VR seems to be a suitable technology to navigate and enhance interactions in, because of its features (Pujol Tost & Economou, 2007). According to a recently proposed definition, virtual reality is a “cognitive environment, created by computational technology, which operates

through the interactive simulation of some aspects of reality (mainly iconic and auditory) in order to obtain knowledge, communicate or create art works" (Pujol, in press cited in Pujol Tost & Economou, 2007, p. 83). This broad definition covers a range of technological trends, including augmented reality, immersive virtual reality, and hybrid reality, and emphasizes that the technology is immersive, virtual, computational and interactive, and that it supports a multimedia, though mainly visual, form of communication (Pujol Tost & Economou, 2007).

The visual form of communication has traditionally been considered the main way of gathering information in a museum context; information was given through texts, images and objects. It is only the recent years, with the development of technology that the shift has gone to include more senses by introducing hands-on activities and reproductions (Pujol Tost & Economou, 2007). Constructivist ideas have contributed to this shift in the way of considering exhibitions, from looking at to immersing visitors in the exhibition, stimulating several senses and emotions (Pujol Tost & Economou, 2007). Pujol Tost & Economou (2007) point out some important factors with the use of VR in a museum setting. It is malleable and flexible, and can therefore combine different communication strategies and contribute to a *virtual layer of information* (Pujol Tost & Economou, 2007, p. 83) in a real space. In this sense VR suits the new multimedia-format of the museum, contributing to a freer movement of the visitor, providing contextual and interpretative information and allowing for personalisation or adaption for the visitors personal interests, cognitive skills and style of learning, which all are fundamental for learning (Pujol Tost & Economou, 2007).

Further, Pujol Tost & Economou (2007) emphasizes that the most important feature of VR is the interactivity it facilitates. Interactivity is an essential quality in the computational origin of VR, and a central pillar in learning and museological theories (Pujol Tost & Economou, 2007). Interactivity in the computational form allows for multi-user communication inside the cyberspace, or a bidirectional communication with the real world in which the machine responds to the user's actions. This can be positive because it facilitates the user in taking control of their own learning process, and opens for explorative learning and collaboration (Pujol Tost & Economou, 2007). As a learning tool, interactivity in VR has a low level of abstraction and is flexible, intuitive and motivational (Pujol Tost & Economou, 2007). VR may also offer personalization for the user, support autonomy and encourage the visitor's personal growth and understanding (Pujol Tost & Economou, 2007).

Though they mainly consider VR as a positive feature for museum learning, Pujol Tost & Economou (2007) question the issue of usability, and the use of ICT overruling the exhibition itself. The basic components and features of VR as discussed in this section are theoretically suitable for museums, but but also impose certain features that might or might not match the exhibition context (Pujol Tost & Economou, 2007). These challenges include linear exclusive communication versus social, environmental interaction; audio-visuality versus multi-sensoriality; partial realism versus full realistic immersion; and finally, personalization but lack of full adaptivity in comparison with human guides (Pujol Tost & Economou, 2007). To meet these challenges, Pujol Tost & Economou (2007) argues for the use of evaluation and gathering of visitors experiences to better design exhibitions and VR experiences. To do this, they state that cognitive, communicational and museological issues needs to be seen as a whole, and interactivity studied as a concept from a social perspective (Pujol Tost & Economou, 2007).

I consider the discussion on VR in museums relevant for my study because of two important factors: the *robot-mediated* field trip to the museum is not a complete virtual experience itself, given that it takes place in a real-world environment in real-time. However, the research on VR in museum gives an idea on how the development and use of technology, virtual experiences, and videoconferencing in museums has led to the possibility for conducting such visit, and is considered of importance to give a broader picture of the technology that has led us to tele-presence robots. The other factor is that if we look at the definition of VR from Pujol (in press), the visit conducted in this study is closely linked to this when it comes to gathering information and knowledge.

2.3 Robotic technology in museums

In their article, Roussou et. al (2000) present the term museum robotics, referring to the development and implementation of mobile robotic technology in museum spaces. Already back then, Roussou et. al. (2000) state that mobile robotic technology and its application in various sectors is currently an area of high interest and research in this field promises advanced developments and novelties in many aspects. They continue their articles with some examples from museums around Europe that have introduced robots to their museum space, indicating that there is a high interest, and maybe even need for museum robotics (Roussou et. al. 2000). More recent articles from Ramon-Vigo et. al. (2016) and Berri, Wolf and Osario

(2014) confirms the increase in development and application of robotic technology in the museum space. Roussou et. al (2000) presents a case where a robot is used as an interactive tour-guide; the TOURBOT. The TOURBOT can act both as a tele-presence robot, thus being an avatar controlled by a visitor over the internet, or it can act as a tour-guide, leading groups and individual around in the museum. However, the TOURBOT does not have a screen showing the person who is controlling it, and thus acts more like an avatar. Berri, Wolf and Osario (2014) and Ramon-Vigo et. al. (2016) both present cases with telepresence-robots that are more similar to the Beam-robot presented in this study. Common for all of them is to explore how visitors engage with, and take advantage of, complex robotic technology, as well as novelty for both the museum space and visitors and conceptual and technical challenges with the use of museum robotics.

A robotic avatar or a tele-presence robot in a museum allows human interaction with, and exploration of a remote site, and this way introduce a novel model of augmented environments (Roussou et. al, 2000). In the case of the TOURBOT, Roussou et. al. (2000) emphasize that not only does the robot open up for visiting from remote sites, but it provides visitors both on and off-site to engage with cutting edge technology, and to see technological advancement implemented in everyday-settings. On the other hand, Roussou et. al. (2000) discuss the complications of such implementation into the museum. The technical challenges are many, such as a providing good internet connection, user- interface and friendliness, and mobile platform design. Also, the museum space itself may not be an ideal environment for navigating a robot in, and the advancement of advanced technology that a tele-presence robot represent may not be *accepted* by other visitors on-site (Roussou et. al., 2000, Ramon-Vigo et. al., 2016). Ramon-Vigo et. al. (2016) addresses this problem through a social navigation experiment, having people navigating a telepresence-robot through a crowd, and registering the reactions. Though their aim is to use these data to enhance the robot's autonomy to become socially adequate, it is interesting and relevant for my study to explore how people react and act towards robotic approaches. Feedback on their experiment showed that people reacted most when the robot was doing “abnormal” things, such as speeding or quickly accelerating. Ramon-Vigo et. al. (2016) also argue that the social situation the person being approached is in matters, for example being in a group versus being alone.

In the information- and globalized society that forms the world, advancement of technology in new areas such as the museum incorporates novel models of access and management (Roussou et. al., 2000). Globalisation and the ever-increasing demand for access, often personalized, to information are the key forces for research in the area of museum robotics. The mobility of the robot allows a personalized and full access museum-experience, where the visitor can choose a variety of viewpoints, based on personal goals and interests and enjoy a museum experience from basically anywhere in the world over the Internet. This way, it provides the means to overcome distance, time limitations and restricted mobility of potential users. In addition, increased interaction with the exhibits and museum staff may be offered, which can be beneficial, especially when visiting science or technology museums (Roussou et. al., 2000).

2.4 Summary

In this chapter I have discussed earlier research and findings in the area of museum learning, field trips, technology enhanced learning, and robotic technology in the museum. Considering the evolving trends over the last years, there is little doubt that within technology lie huge opportunities for museums to enter new areas for communicating and for designing exhibitions. Technological development is evolving so fast, it can be hard for institutions, and human beings, to keep up with it (Pujol-Tost & Economou, 2007). To introduce technology just for the sake of technology is not a solution. Instead, museums need to critically assess the use and implementation of novel technology in their practice, to see and understand how such technology can be an asset to reach a broader audience, and to serve as an educating institution (Roussou et. al., 2000).

This study is considered a contribution to the area of learning with museum robotics (Roussou et. al., 2000), and I seek to explore and assess the opportunities for learning in a museum with novel technology. The aim for this study is to investigate how a telepresence-robot can provide a school-class with a meaningful learning experience in a museum. This chapter on earlier findings and research is meant to give an overview on activity in the field of learning and technology in museums, and will serve as background for my analysis of data and findings later in this thesis.

3 Theoretical perspectives

This chapter is devoted to clarify the theoretical perspectives that constitute the foundation for this thesis. My work with this study is grounded in a sociocultural and dialogical perspective on learning. These views are first represented as foundational theories, and then relevant concepts are discussed in a museum context.

3.1 A sociocultural learning perspective

It is reasonable to claim that almost all theoretical frameworks related to sociocultural learning are, in some way, connected to the work of Lev S. Vygotsky (1896-1934). Vygotsky was a Russian psychologist, and was groundbreaking with his theory of human development and learning as something that occurs when we interact with others, with our surroundings, and through mediated artefacts (Vygotsky, 1978). At the core of this theory is Vygotsky's belief that human development is the result of interactions between people and their social environment. These interactions are not limited to actual people but also involve cultural artefacts, mainly language-based (written languages, number systems, various signs, and symbols). From Vygotsky's point of view, artefacts serve a dual purpose: they integrate a person into their cultural environment, and at the same time they transform and shape the mind of the person. As a result of using these tools, first in cooperation with others and later independently, humans develop higher mental functions. These are complex mental processes that are intentional, self-regulated, and mediated by language and other sign systems, such as focused attention, deliberate memory, and verbal thinking. According to Vygotsky, although all human beings are capable of developing these functions, the particular structure and content of higher mental functions depend on the social and cultural environment they are surrounded with, and the artefacts and tools they interact with (Vygotsky, 1978).

Vygotsky's foundational theories has been elaborated and discussed in the world of psychology, social sciences and humanities throughout the last century. Wertsch (1991) draw on the ideas from Vygotsky, and of the Russian literature, language and culture- theoretician Mikhail Bakhtin (1895-1975), and argues that the interactions between the human mind and tools and artefacts is so fundamental, that when describing human action it is necessary to consider it as individuals acting or operating with mediational means. From a sociocultural perspective then, it is not possible to study individual learning and development without

including interactions with other humans, and mediated artefacts. To understand learning we have to understand how people interact with the mediational means they use in their interactions (Andersson & Jakobsson, 2012). Säljö (2001) states that if we only consider learning as something that occurs in each individual, we lose our understanding of how cultural products, put at our disposal, affect our thoughts and actions. Andersson & Jakobsson (2012) cites Wertsch (1998) to sum up the sociocultural approach to learning: "The task of a sociocultural approach is to explicate the relationships between human action, on the one hand, and the cultural, institutional, and historical contexts in which this action occurs, on the other" (p. 7). Considering this, the essence of the sociocultural learning theory is to focus on how learners interact through artefacts accessible to them, and how these artefacts mediate human action and thought. In a museum context this means that focus need to be on the visitors interactions with exhibits, and their encounters with other visitors and staff members during a visit (Andersson & Jakobsson, 2012). When designing and planning for the field trip to Musée des Confluences with a telepresence robot, the idea of what types of interactions would occur, both human-mediated and mediated by technology and artefacts in the exhibition, and how the group would learn from these interactions were hypothesized based on previous studies and research findings (Sandoval, 2013). The visit as a whole is planned and grounded in a sociocultural learning perspective, and the interactions and dialogues were considered most important for creating a learning experience.

3.1.1 Mediation and artefacts

A recent definition that can help concretize the term artefact has been proposed by Cole (1996) who draws on the perspectives of Vygotsky and a socio-cultural historical context: "An aspect of the material world that has been modified over the history of its incorporation into goal-directed human action. By virtue of the changes wrought in the process of their creation and use, artefacts are simultaneously ideal (conceptual) and material" (p. 117, in Andersson & Jakobsson, 2012 p. 4). Based on this definition, an artefact and its users are connected in a dialectical and reciprocal relationship, where artefacts mediates the user's thoughts and actions, and where users mutually contribute to develop the artefact by adding new inventions or applications (Andersson & Jakobsson, 2012).

Wertsch (1991) has elaborated on Vygotsky's ideas on artefacts, and defined what he considers psychological tools or means for thinking such as language, symbols or formulas,

and tools as technical means such as computers or calculators. As artefacts (books, games, scientific concepts) that exist in our surroundings, they become potentially relevant as tools that mediate our thinking and interaction with the world (Andersson & Jakobsson, 2012). It is necessary to thoroughly analyse both the artefact and the use and understanding of it, what characteristics they have and what significance they may pose in the process of mediating human learning and development (Andersson & Jakobsson, 2012). According to Cole (1996) artefacts are ideal and material precisely because of this dialectical relationship, and that the interactions between humans and the physical world may be seen as integrated in the artefact. Säljö (2005) emphasizes that when an artefact is constructed, it is crucial that the producer needs to have extensive knowledge of the process, and how to enhance the features of the tool. This is important because when an artefact is constructed, the material is transformed from one state to another, based on human experience and knowledge (Säljö, 2005). The user of the artefact may not hold the same knowledge, but they still take advantage of the enhancements made, and thereby share a collective experience (Andersson & Jakobsson, 2012).

3.1.2 Mediation and artefacts in museums

In a museum exhibition context, artefacts have traditionally been a crucial part of human activity. The role of the museum has been to collect and conserve cultural tools, to use these tools in research and to put them on display for the purpose of educating the public (Andersson & Jakobsson, 2012). However, these artefacts are removed from their natural habitat and surroundings, which may decrease the possibility of the visitor gaining a full understanding of their meaning and application in their natural environment (Andersson & Jakobsson, 2012).

The idea of interactions and artefacts might have significant implications for the understanding of visitors learning processes in museums (Andersson & Jakobsson, 2012). To consider learning as something that occurs through interacting with artefacts in the museum can help us understand how learning actually evolve in these contexts. Focus on technical devices and their way of mediating and enhancing knowledge to visitors is a way of exploring and understanding how meaningful interactions with cultural artefacts occur in the museum. In this study of students visiting the museum using a robot, I seek to investigate how this type of technology may serve as a novel way of mediating meaningful learning experiences in

museums. Results from studies related to this, indicates that it is possible to enhance visitors learning through different technical devices (e.g. Lindemann-Matthies & Kamer, 2006; Novey & Hall, 2007; Swanagan, 2000 in Andersson & Jakobsson, 2012).

Earlier studies have tended to focus on visitors learning outcomes by assessing their knowledge on a certain topic before and after the visit, by studying conversations between family members, school groups or visitors and staff (Andersson & Jakobsson, 2012). These conversations are studied by Leinhardt & Knutson (2004) related to identity; not in the social-demographic way (age, gender, income etc.) but in terms of the collective dispositions, motivations, stances and experiences that groups brings to interactions at a particular place at a particular time. Identity represents visitors' intentions and motivation for visiting the exhibit, and also filters and shapes their experience and has an impact after visiting an exhibition (Leinhardt & Knutson, 2004). Additionally, studies have focused on the individual's interactions with the exhibition, for example by analysing how much time they spend on each activity. However, few studies have focused on the relationship between visitors' conversations and the artefacts embedded in the exhibition context, and on if, how and in what ways these artefacts may mediate visitors' dialogues during the visit (Andersson & Jakobsson, 2012). The aim of this study is to contribute to this area, to investigate how dialogue within a group and interactions with artefacts shape the student's collaborative learning experience in museums.

3.2 Islands of expertise

Crowley & Jacobs (2002) introduce the theory of *islands of expertise* in their research on early childhood learning. Long before children enter academic disciplines, they start developing informal knowledge on specific topics in academic fields such as science and language (Crowley & Jacobs, 2002). They do so through everyday experiences and interactions with their environment, such as a walk in the park, a visit to a museum and interactions with other human beings. Crowley & Jacobs (2002) also emphasize the role of parents as mediators when attaining such knowledge. An island of expertise is a topic that a child happens to be interested in, and then becomes an area in which they develop relatively deep, specific and rich knowledge (Crowley & Jacobs, 2002). Developing an island is a social activity, because of its role in everyday activities including often other family members, primarily the parents, and an island typically takes weeks, months or even years to develop

(Crowley & Jacobs, 2002). This can be illustrated by "Tomas the Tank Engine example" (Crowley & Jacobs, 2002). A two-year old gets a book of Tomas the Tank Engine for his birthday. He likes the book, and he watches the movies where he learns about steam-locomotives. His parents buy him a toy of Tomas for his next birthday, and plan their next holiday or weekend to visit a museum where you can see real steam locomotives. This demonstrates that developing islands of expertise is a highly social, collaborative and interest-driven effort (Crowley & Jacobs, 2002). Through this process, the child (and his parents) gather new information on the topic, perhaps learning names and brands of locomotives, and how their mechanism function, knowledge that is transferable to other science domains (Crowley & Jacobs, 2002). All these experiences lead the child to memorize domain specific knowledge from Tomas the tank engine to real trains, mediated by his parents. By the time he turns three, he has developed a vocabulary, declarative and conceptual knowledge and personal memories in his island of expertise on trains (Crowley & Jacobs, 2002). The theory on islands of expertise is included to demonstrate that children enter the school area with different preconditions and pre-understandings of academic subjects. This is important to consider when designing and conducting novel informal learning experiences, such as the study in this thesis.

3.3 A dialogical approach to learning in museums

So far I have discussed some key concepts of sociocultural learning, and the role of artefacts and mediation in museums. In this section I will elaborate on the dialogical approach to learning in museums.

In recent museum learning- research, as discussed above, there has been a shift of paradigm in the way we understand museums (Dysthe, Bernhardt & Esbjørn, 2012). From considering the museum as a classical authoritative and formatting institution, where knowledge is distributed from the inside and out to the public, the public are now considered participants and co-constructors in a dialogue of the knowledge and experiences taking place in the museum (Dysthe, Bernhardt & Esbjørn, 2012; Kidd, 2014). The inspiration for dialogical learning comes from the Russian literature, language and culture- theoretician Mikhail Bakhtin (1895-1975). However, his field of interest was not pedagogy, and he is therefore considered a source of inspiration, more than a fundamental theoretician for specific didactical practices (Dysthe, Bernhardt & Esbjørn, 2012). Where theoreticians such as Freire, Rogers and Buber

represent a view of dialogue that challenges the individual understanding of meaning making as an autonomous activity, Bakhtin represents an alternative (Dysthe, Bernhardt & Esbjørn, 2012). Bakhtin and Vygotsky lived at the same time, and they share the stance on the significance of social interaction for human learning and development. Bakhtin contributes thoughts on dialogue as the foundation for all interpersonal interactions. According to Bakhtin, the truth is dialogical in nature, and the need for creating dialogue involves "the other", that the whole version can only be seen by supplementing with what "the other" sees (Dysthe, Bernhardt & Esbjørn, 2012). Bakhtin uses the term voice to describe the speaking personality "A person enters into dialogue as an integral voice. He participates in it not only with his thoughts, but with his fate and with his entire individuality" (Bakhtin, 1981, cited in Dysthe, Bernhardt & Esbjørn, 2012, p. 59). This means that when a person or voice makes a statement, the statement is always based on their angles, and affected by sociocultural and personal experiences (Wertsch, 1991; Dysthe, Bernhardt & Esbjørn, 2012).

According to Bakhtin's view, understanding and the development of knowledge occurs through negotiation between different voices, and it is when these voices represent conflicting views that learning potential is at highest (Dysthe, Bernhardt & Esbjørn, 2012). For the relation to be dialogical it is not enough that different voices and ideas are co-existing, the ideas need to be tested through confrontation to be dialogical. An important factor of Bakhtin's view is that consensus is not the goal. Rather it appreciates diversity, the expression of different opinions, and the acceptance of living with opposites, or what he refer to as *multivocality* (Dysthe, Bernhardt & Esbjørn, 2012). Dysthe, Bernhardt & Esbjørn (2012) draws on the dialogical perspective of Bakhtin, and use this as an analytical framework for studying learning in a museum and school-learning context. Stating that the goal of museum learning is not only to facilitate a positive experience, or to impart knowledge, but to contribute to students' understanding, insight and critical reflection, and they analyse how students enter into multivocal dialogues in exhibitions (Dysthe, Bernhardt & Esbjørn, 2012).

From a dialogical perspective, meaning occurs in the interaction between the communicators, and the response from the other is the activating principle that creates understanding. Thus, meaning cannot be created individually, but is something that occurs between "us" (Dysthe, Bernhardt & Esbjørn, 2012). Bakhtin states that "truth is not born nor is it to be found inside the head of an individual person, it is born between people collectively searching for truth, in

the process of their dialogic interaction" (Bakhtin, 1984, cited in Dysthe, Bernhardt & Esbjørn, 2012, p. 58). When analysing data, I will draw on these perspectives to understand how meaning is created between the students, and how mediated artefacts in the museum drives their actions, interactions and dialogue.

3.4 Summary

A sociocultural perspective on learning, grounded in Vygotsky's theories, focuses on human interactions, and how these interactions are mediated by other humans, artefacts and tools. From a dialogical perspective, meaning, learning and understanding occur through dialogue and interaction, and where multivocality and diversity are central.

To sum up sociocultural and dialogical perspectives on learning, it is possible to state that the process that leads to learning consists of interactions and dialogues, between humans and mediating artefacts, or what can be referred to as *social meaning making* (Vygotsky, 1978; Wertsch, 1991; Säljö, 2001). To understand how this process occurs in museums, it is necessary to focus on visitors interactions in authentic situations (Andersson & Jakobsson, 2012), and to focus on how dialogue and artefacts mediate these interactions (Dysthe, Bernhardt & Esbjørn, 2012).

3.5 A sociocultural model for learning in museums

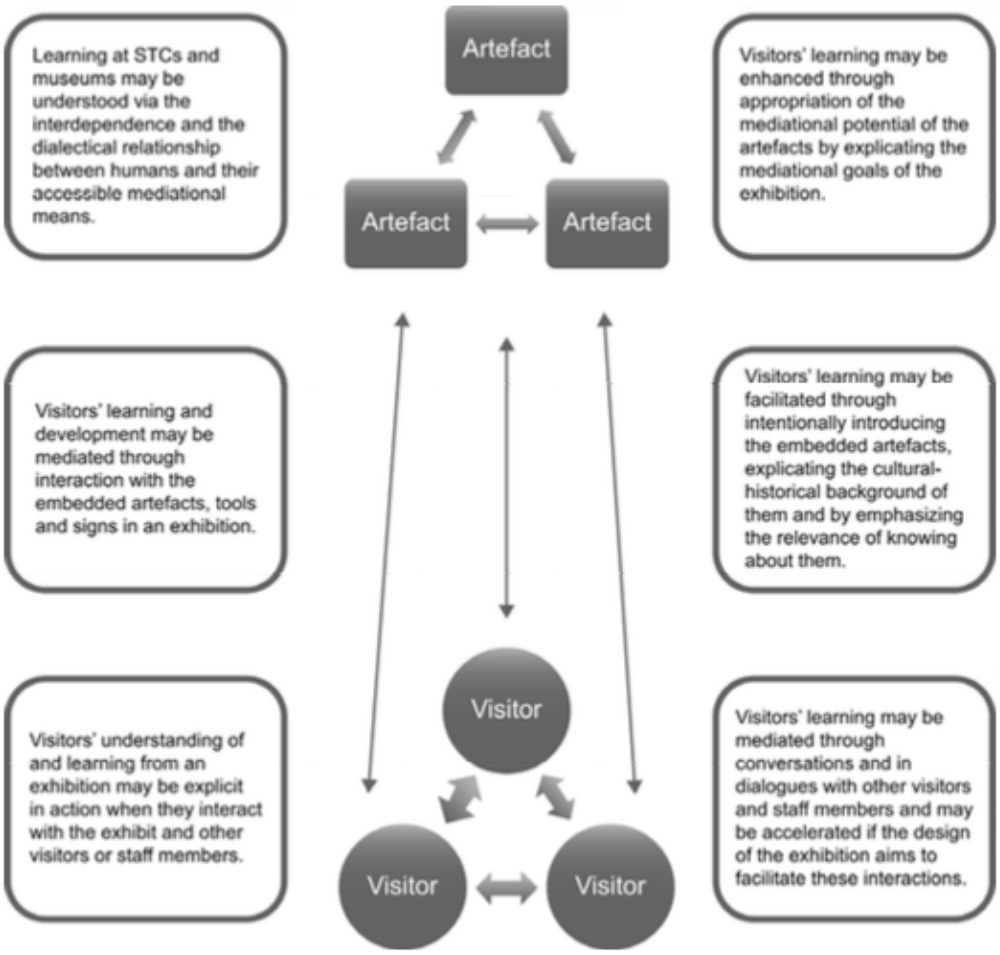

Figure 1. Model of learning and development in STCs and museums (Andersson & Jakobsson, 2012).

The model is developed by Andersson & Jakobsson (2012), in order to explore and increase our understanding of learning in museums and science and technology centers (STCs). With a stance in sociocultural theory, the model aims to explore and understand the role of interactions in museums and STCs, and how these interactions impact human development and learning (Andersson & Jakobsson, 2012). This model will work as a tool and supplement to my theoretical grounding when analysing data in this study. I do not apply the model directly in the analytical approach, but use it as a supplementing tool for understanding and analysing the interactions taking place in the groups of students, mediated by artefacts in the museum. By analysing interactions with artefacts and between visitors, in my case represented by both the groups of students and by visitors in the museum, I seek to investigate

how these interactions fosters learning and meaning making activity in the visit with the robot. This is where the model will work as a tool, to clarify the relationship between the students, interactions in the group and how these are all mediated by artefacts in the museum.

3.5.1 Explanation of the model

The circles in the bottom of the model, marked *visitor*, illustrate the visitors and their interactions with each other during a visit. These circles focus on human mediation, and illustrate the group of students in this study, the museum guide and other visitors present in the museum. The squares on top of the model, marked *artefacts* correspond to the exhibition, and its embedded artefacts. These illustrate the exhibition as a whole, a separate or related exhibit, or parts of the exhibition (Andersson & Jakobsson, 2012). The term embedded artefacts used here, aims to describe the scientific concepts, theories, explanatory models, signs and tools included in the exhibition (Andersson & Jakobsson, 2012). The bidirectional arrows demonstrate on one side, how the artefacts affect and have an impact on the conversations and visitors' mediation, and on the other side, the process on how humans influence the artefacts (Andersson & Jakobsson, 2012). The latter is however unusual in an exhibition context, as it demonstrates human impact on artefact development. In museums the exhibition and artefacts aim to impact human thoughts and development, not the other way around (Andersson & Jakobsson, 2012). Finally the text boxes represent the learning principles the model is based on, on the left side, and some examples on how to enhance interactions in museums and SCTs are presented on the right side (Andersson & Jakobsson, 2012).

3.5.2 Summary

The model represents a sociocultural view on learning in museums, with focus on interactions mediated by humans and artefacts. When addressing my research question "*How does a telepresence robot mediate learning and interactions in a museum context?"* and "*in which way do these interactions enhance learning and understanding?"*, the interactions and dialogues between the students and students and museum-staff is essential, and the model will be used as a tool to see if and how these interactions fosters learning and understanding of the exhibition, and how they contribute to social meaning making within a group.

4 Research design

In this chapter I will first go into the background and context for the case study presented in this thesis. Further I will present method and research design, and then, in the following subsection I will go through types of data collected. Finally, a section is dedicated to the analytical approach, reliability and validity of this study, and my role as a researcher.

4.1 Context for research

As part of my master's degree in Educational science: Communication, design and learning, I was on an exchange at École Normale Supérieure (ENS) in Lyon, France, during the fall-semester of 2015. The courses I attended are part of a master's degree in Information Architecture. Information architecture is defined as specializing in organising and retrieving information, and optimizing user experiences. Within this master degree the ENS Lyon offers a course called *Models and settings for e-learning*, which I attended. This course aims to enhance the students understanding of issues, trends and development in distance and online education, to be able to analyze learning situations in light of pedagogical theory, and to be able to understand the tools and models to design and analyze e-learning situations. E-learning has naturally emerged from the rapid progress of internet and the technological development of interactive communication tools, and is by Garrison (2002) defined as *electronically mediated asynchronous and synchronous communication for the purpose of constructing and confirming knowledge* (p. 2).

4.1.1 Musée des Confluences in Lyon

A larger part of this course was to conduct a project regarding an e-learning situation. The task was quite open with few guidelines besides the e-learning aspect. I teamed up with one other student from the class, and we decided that we wanted to explore an informal learning situation. We visited the Musée des Confluences, a natural science and history -museum that opened in 2014. It is situated in a futuristic building, the exhibitions are interactive and technological and represent the newest forms of museum-technology.
We learned that during their inauguration of the museum, the Musée des Confluences had used telepresence- robots, and invited among other hospitalized children to visit the museum from their hospital-beds. We found this idea intriguing, and wanted to explore the possibilities

of learning with a telepresence-robot in a natural science museum. After two visits to the museum, we decided to design our project around the permanent exhibition *Origins: stories of the world*, which explores the question of the origins of the universe and of humanity. We confined the visit to this permanent exhibit, with thoughts that our design would be transferable to other schools who wish to conduct the same visit, and because of the relation to curriculum the 5th grade class conducting the visit was working with at that time. The exhibition takes visitors back in time to the Big Bang by two approaches to explaining the world: one scientific and the other symbolic. The exhibit includes fossils of dinosaurs and other prehistoric creatures, pieces of a meteorite, and one from the moon, and in addition stories and myths on how the world was created from indigenous people such as the aborigines, Inuit and Indians.

Figure 2. Musée des Confluences.

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4.1.2 Beam: a telepresence robot

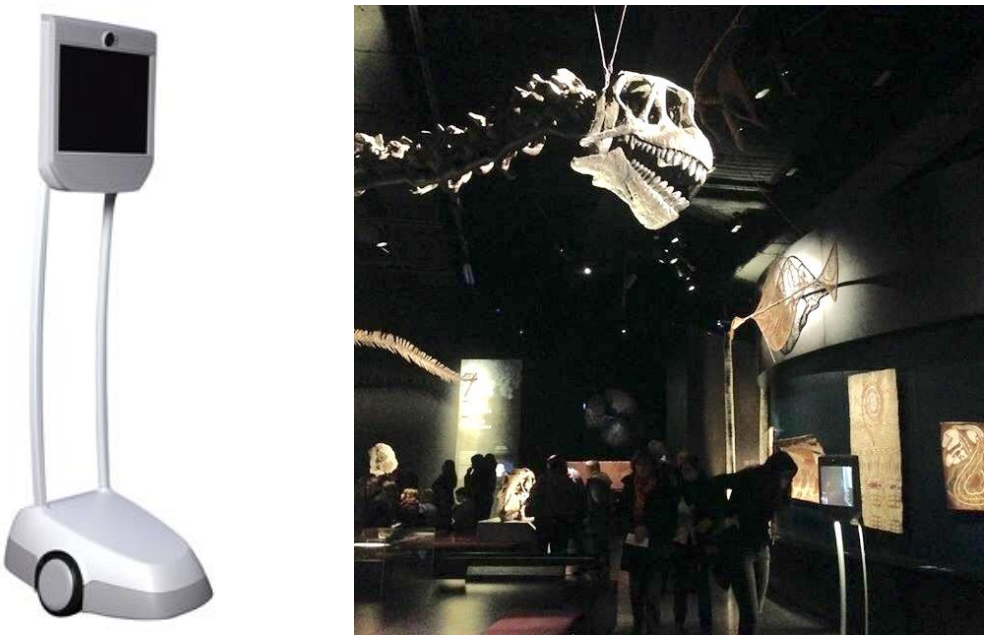

Figure 3. Beam: a telepresence robot.

Through a research-project I participated in at the French Institute of Education (IFE), during my stay at ENS Lyon, I learned about a company called Awabot, which distributes smart-robots for educational, cultural, health, and business - purposes. The company was responsible for providing the robots used during the inauguration of the Musée des Confluences, called Beam. The Beam telepresence- robot is developed by Suitable Technologies. It consists of a tripod with a screen, in average eyes-height, and optionally one at the bottom, attached to a platform with wheels that makes it mobile. It is controlled remotely from a computer over the internet, using a single interface and the arrow-keys on the keyboard. The person who controls it sees on the screen of his/her computer, all that is facing the robot and moves around as he/she likes, being visible on the screen, and audible through the speakers of the robot.

4.2 Method

In this section I will argue for the methodical approach to the case study, first discussing what conducting a case study means, and then explaining the concept of design based research and design-experiments and how they are applied in this study.

4.2.1 Case study

This case study is conducted with the aim to explore and understand the possibilities for learning with a telepresence-robot in a natural science museum. Conducting a case study is often the preferred method when investigating complex social phenomena (Yin, 2009). Defined by Yin (2009), a case study is an empirical inquiry that "investigates a contemporary phenomenon in-depth, and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 18). The essence of a case study is about finding and defining tendencies, that it tries to illuminate a decision, or a set of decisions, why they were taken and how they were implemented, and the effects and results of these implementations (Yin, 2009). The case study as a research strategy comprises an all-encompassing method, with the logic of design incorporating specific approaches to data collection and data analysis. The case study inquiry relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and where results from data does not come out as one result but as several variables of interest, and where prior development of theoretical propositions are beneficial to guide data collection and analysis (Yin, 2009).

This particular case-study is carried out as a design-experiment (Brown, 1992). This manner is discussed in greater detail below. Based on field-trip literature and a constructed grid for e-learning from our course at ENS Lyon, we designed an e-learning case study for visiting the Musée des Confluences with a telepresence-robot. The goal was to explore the possibilities of learning with a telepresence-robot in a natural science museum, by intervening with existing practices in both traditional teaching methods in the classroom, and traditional field-trips to the museum (Falk & Dierking, 2000). The designed tasks for the visit mainly involved collecting information to answer a series of questions from a worksheet. Information could be collected by controlling the robot to visit the exhibit, talk with the museum-guide or interact with other visitors at the museum. Our first idea was to have a Norwegian class conduct the

visit, to emphasize the possibilities of mobility and distance the robot offers. Due to logistical problems and a short time-frame, this was proven hard to go through with, and we decided to carry out the project with a French 5th-grade class that I had been working with through the research project at IFE. The 22 participants were between 10 and 11 years old when the visit was conducted.

4.2.2 Design based research

Educational design-based research is the systematic study of designing, developing and evaluating educational programs, processes and products (van den Akker, Gravemeijer, McKenney & Nieveen, 2006). In a broad perspective design based research aims at creating innovative learning ecologies in order to develop local instructions theories on one hand, and to study the forms of learning that those learning ecologies are intended to support on the other hand (van den Akker et.al. 2006). Educational design research is thus about creating and understanding innovative learning arenas, for developing new forms of education. The aim of this study is to investigate the novelty of using interactive robotic technology for expanding the classroom, to seek out how informal and traditional learning areas can meet to form the new classroom pedagogy needed for the 21st century.

4.2.3 Design experiment

This case study is conducted as a design experiment (Brown, 1992), in the way it intervenes with existing practices both in form of traditional field trips, and with traditional teaching methods. Design experiments were developed as a way to carry out formative research to test and refine educational designs based on principles derived from prior research (Collins, Joseph & Bielaczyc, 2004). My case study is designed as an intervention in existing classroom practice, and in museum field-trip practice. I will then analyse the outcome and effect on this intervention, based on prior research and theory concerning field trips, learning in museums and use of technology for learning. Van den Akker et. al. (2006) describes design experiments as the development of theories about both the process of learning, and the means designed to support that learning. Brown (1992) and Collins (1992) characterises design experiments as:

- addressing complex problems in real contexts in collaboration with practitioners
- integrating known and hypothetical design principles with technological advances to render plausible solutions to these complex problems
- conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles

Design experiments in the setting of computer based collaborative learning (CSCL) has been criticised for not taking into account contextual and institutional issues, pointing to crucial factors of impact that lies outside of the design experiment itself (Fjuk, 1997, in Krange & Ludvigsen, 2009). An important factor for the design experiment to be a successful research method is to put the focus beyond the design of the technology and concentrate on the use of it, in this case how the robot can be a useful, interactive tool for learning (Rabardel & Bourmaud, 2003 in Krange & Ludvigsen, 2009). Krange & Ludvigsen (2009) refers to Brown's and others definition as the "mainstream" definition of what a design experiment is, and draws similarities with lab-studies. Further they argue to include institutional settings, such as the school as a curriculum deliverer and to see how these issues appear when student interact with technology in knowledge constructing settings (Krange & Ludvigsen, 2009). In my case study this is an important factor, when analysing the interactions occurring during the visit with the robot. Also, where Brown (1992) sees the design experiment as something to be repeated and perfected into a model, Engeström (2007, in Krange & Ludvigsen, 2009) has emphasized the need for open-ended character for educational change processes, a view that correspond with my way of thinking and conducting this case study. This study contributed to the museum´s ongoing and iterative work to develop innovative technology-enhanced learning experiences for students and teachers on school field trips. In this sense, the method corresponds with the iterative aims of design-based research.

4.3 Data context

In the previous sections I have gone through the context and the methodological approach for the study. In this subsection I will go through the context for collecting data, discuss qualitative vs. quantitative and present how and what types of data are collected in this study.

4.3.1 Qualitative vs. quantitative data

King and Horrocks (2010) refer to qualitative and quantitative research as two *paradigms* in research, and claims that these represent two differentiated views on the world. Quantitative research focus on capturing the social world through precise measure and statistical data, represented in numbers and variables. Qualitative research also aims to explain the social world, according to King and Horrocks (2010) it builds on a socio-constructivist view of the individual, meaning that social phenomenons varies depending on the context, and is in a continuous change. This has also been the biggest issue when it comes to research on social and psychological phenomenons, such as learning (van den Akker et. al. 2006). Befring (2004) argues that the fundamental difference between qualitative and quantitative method is related to the research-objectives and the characteristics of the data. Qualitative data are often the result of participating observations, unstructured interviews and open presentations or other unstructured techniques (Lund, 2002). Qualitative data is often inquiry based, and seeks to explain idiographic knowledge - what characterises the distinctive nature on research in a specific case or area. Qualitative data and is often represented in form of a case study, or individual cases (Lund, 2002). Qualitative methods were used in this study. Data are collected in form of a case-study, through audio-recordings of the conducted visit to the museum, informal meetings with representatives from the museum and with the teacher, semi-structured interviews with teacher and museum guide, a semi-planned debriefing session, and a questionnaire given to the students right after the visit.

4.3.2 Limitations within the Beam robot

An important factor to figure out was the possibilities and the limitations lying in the use of the Beam. I had the opportunity to test the robot in another setting, on a visit to an open-day event at another university in Lyon. This was crucial to explore how the user interface was experienced, and what you could actually see and do once "in" the robot. I experienced it as easy to move around, to both hear and to speak with others, but we figured out that reading signs were quite difficult unless the robot is really close. The camera-angle also has its limitations, especially facing up or down, which was important, considering looking at the large skeletons of dinosaurs or mammoths.

Especially the limit of reading-ability forced us to make some adjustments, as we had relied on the students being able to read the posters in the exhibition. This required us to include a museum-guide in the visit. When discussing with the teacher and museum guide, we also took into consideration that the robot is made to be used by one person at the time, while we created groups of up to six students that were going to use it at the same time. Because of the limited schedule of the museum guide, each group had 20 a time-frame of 20 minutes to solve the given tasks and to explore the exhibition. We therefore created a list of instructions to be undergone by the group to make roles and the storyline of the assignment clear, for the students to be prepared and actually spend the time focusing on the visit and the tasks.

4.3.3 Group composition and working environment

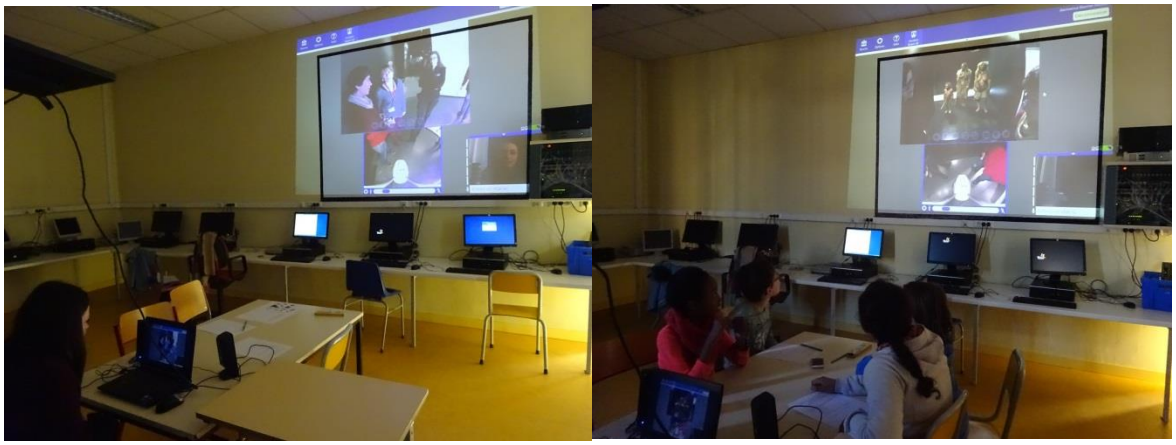

Figure 4. Working environment in computerlab.

The groups of students were put together by the teacher, based on his knowledge on who works together, for a balanced collaboration in the group. The class in total consists of 24 students, but during the conduction of the visit only 22 of them was present. In Group 1 there are two girls and four boys, in group 2 there is three boys and two girls, in group 3 there are five girls and group 4 consists of three boys and three girls. More important than dividing by gender, the teacher considered who works well together, and tried to create dynamic-groups and a safe environment where it would be possible for everyone to speak up and share their opinions.

The computer for the visit was set up in the computer-lab of the school. In this room there is a projector and speakers, making it possible to project what are seen from the camera of the

robot onto a big screen. The person controlling the robot was sitting in front of the laptop (to the left in the picture), while the rest of the group were seated around the table, watching the big-screen. The top of the screen shows what you are seeing through the robot's upper camera, while the bottom shows what you see through the lower camera. The lower camera is useful to see where you are moving, and make sure you do not hit anything in the room you are moving around in. In the right corner of the big screen you can see yourself as you are shown on the robot's screen.

4.4 Data collection and types of data

When using a qualitative approach, data collection consists of several types of data (King & Horrocks, 2010). Collecting several types of data allows the researcher to create a broad picture of the case that is being studied. In my study I have audio recordings as my main source of information from the visit. As a supplement I took field notes during the whole visit, to remember and structure occurring observations that are limited in the audio-recordings, such as gestures and nonverbal interaction (Brown, 1992). Excerpts from the audio-recordings are used in the analytical part of this thesis, and answers from questionnaires, interviews and field notes serves as a supplement when analysing and discussing findings from the excerpts. The table below demonstrates a full overview of all data collected in this study.

Design data	**Pre-visit**	**Visit**	**Post-visit**	**Debriefing**
- notes from meeting with the museum - notes from meeting with the teacher - notes on testing/ communication with Awabot: limits of the robot, practical and logistical communication - student work sheet for the visit - map of the exhibition for bonus-questions	- teachers plan for session - field notes on introduction	- audio recordings of four groups, 20 minutes each (80 min. in total) - worksheets with given tasks containing each group's answers - map of the exhibition with groups marks on it - pictures - field-notes from each groups visit	- student questionnaires - video- interview with museum guide	- teachers plan and questions for debriefing- session - field-notes from debriefing session - pictures

Table 1. Table of data collection.

4.4.1 Collaboration with museum and school

Our meetings with the museum and with the teacher were semi-structured (Silverman, 2005), with few questions prepared beforehand, as the goal was to receive feedback on the tasks designed for the visit. After our first draft we first had a meeting with the museum where we presented the project and the designed tasks. We were given feedback on formulations and adjustments regarding the content and questions to fit the exhibition. The museum also explained how they normally conduct class-visits, and agreed to provide us with a guide for our tour with the robot. After meeting with the museum, we sat down with the teacher to discuss the questions for the worksheets. He provided us with useful input on the curriculum, where and how he thoughts the students could use prior knowledge, and how to organise the conduction of the visit both practically and to enhance learning outcomes for the students.

4.4.2 Worksheets, audio recordings and questionnaire

The groups were given different worksheets, each including one main question, and two additional questions linked to objects in the *Origins* exhibition (appendix). The questions were created together with the teacher, based on curriculum for 5th grade in natural science, geography and history, combined with the possibilities in the exhibition. In addition, they were all given the same bonus question. When the groups had managed to answer given questions, the bonus question was a blank map that represented the room of the exhibition (see Appendix 4). Here they were asked to move freely around in the exhibition, encouraged to ask the museum guide or other visitors what they were looking at, and try to mark it on the blank map.

The audio-recordings were taped using a recorder, during the whole 20-minutes session for each group, thus containing all conversations and sound within the group, communication with the museum-guide and researcher on site, and other visitors in the museum (see Appendix 1).

The questionnaire given to the students directly after the visit to the museum was created in cooperation with the teacher. The questions were designed based on our thoughts and possible outcomes for the experience and our set learning goals for the work-sheets during the visit. In addition I wanted some background-material on how familiar the students were with museum-

visits, and their opinion on the experience with the robot. This data will be used in the analysis and discussion part of this thesis, where it seems relevant (see Appendix 3).

4.4.3 Debriefing session

The debriefing session was mainly planned by the teacher, with inputs from me. He wished to link this to previous and future work in the classroom, both the experience with the robot itself, and the knowledge gained. In the debriefing-session each group presented their questions and the answers they had found, and were given the freedom to involve other things or questions that had appeared during the visit. During the presentations and in the end of the session, the teacher planned for an open discussion involving the whole class.

4.5 Analytical approach

This subsection concerns a critical reflection on the use of interaction analysis as a method, on the design, validity and reliability of this study, and on my role as a researcher.

4.5.1 Interaction analysis

My recordings in this study, and analysis of these, draw on the method of interaction analysis. Interaction analysis is described as an "interdisciplinary method for the empirical investigation of the interaction of human beings with each other and with objects in their environment" (Jordan & Henderson, 1995, p. 39). Interaction analysis aims to investigate human activities, such as verbal and nonverbal interactions, and the use of artefacts and technologies, to identify routines, practices and problems and based on these draw conclusions and find solutions (Jordan & Henderson, 1995). By using this method, I aim to better understand the interactions and learning-processes that take place during the visit. An underlying assumption and premise for interaction analysis is a view on learning and knowledge as fundamentally social in their origin, organisation and use, and situated in particular social and material ecologies (Jordan & Henderson, 1995). Thus, expert knowledge and practice are not considered as something located in the minds of individuals, but as situated in the interactions among members in a particular community, engaging with artefacts (Jordan & Henderson, 1995). This supports my theoretical stance, considering

learning a social activity, through dialogue and mediated artefacts. This view has consequences for interaction analysis as a method; creating theories regarding learning is not grounded in traces of cranial activity, such as survey or protocol data, but lies in the "details of social interactions in time and space, and, particularly in the naturally occurring, everyday interactions among members of communities of practice" (Jordan & Henderson, 1995, p. 41). From this point of view, artefacts and technologies frame a social field, where some activities are more likely to happen than others. The goal of analysing the four sequences is to identify routines and define regularities where the students manage to utilize their resources from both the social setting they are confronted with in their groups, and the material world presented in the exhibition to create meaning (Jordan & Henderson, 1995). Interaction analysis also draws on the assumption that verifiable observation provides the best foundation for analytic knowledge on the world (Jordan & Henderson, 1995). When analysing the sequences I will draw findings based on the interactions, from a stance that they have self-value. This way, my interaction analysis relates to committing to grounding theories in empirical knowledge, and generalizing from records of naturally occurring activities accounts for theories supported in the evidence that are the interactions (Jordan & Henderson, 1995).

4.5.2 Validity, reliability and generalisation of data

My research design is a design experiment intervention in a French classroom and in a natural science and history -museum. My data collection consists of audio-recordings, photos, field notes, a questionnaire for the students and interviews with the class' teacher and with the museum guide. The aim of this study is to contribute to the fields of field trip studies, museum learning and computer supported collaborative learning (CSCL) represented by learning with novel robotic technology. As a researcher it is my responsibility to make sure the data selected is representative, and not only a narrow selection to emphasize my point of view (Brown, 1992). My selection of data sequences presented in the thesis is done by thorough and critical assessment, to illustrate my theoretical grounding and findings. Social research often include a comprehensive amount of data, and interviews, ethnographic studies, field notes and transcript conversation needs to be narrowed down to a small sample, that seeks to support the theoretical point of the research (Brown, 1992). Brown (1992) emphasize that the selection is nontrivial, but the issue is how to avoid misinterpretation of the selected data. When analysing and interpreting data, there is always a risk that the

researcher interprets based on a pre-understanding (Dalen, 2011), because I as a researcher will always have an inside-view on the data. This was a crucial point when I was transcribing the audio-recordings. I know that when I am the researcher, I will always have certain subjectivity, and in this case I also had to translate from French to English while transcribing, meaning I had to take into account language errors and making sure things did not get lost in translation. Also, by having only audio-recordings, there is a chance I have missed out on some non-verbal communication that could have given a broader picture of what was happening in the interactions (Jordan & Henderson, 2005). I have taken this into account when arguing for theoretical grounding, in form of a sociocultural model and a dialogical approach. By collecting and analysing the interactions through several qualitative methods, I aim to give a rich description that represents a realistic and complete picture of the case.

Reliability concerns the credibility of the research, and if this would have given the same results conducted by another researcher using the same method (Merriam, 1998). By thoroughly presenting my method, data and approach to analysing these, I aim to demonstrate the foundation on which I base my findings, to emphasize the reliability of this research (Silverman, 2005). Generalisation of research concerns whether the findings of a study is transferable to other similar situations (Silverman, 2005). The findings in this study are related to a specific context, and intervention in practice, and the individual's personal experience and commitment. This study alone may therefore be hard to generalize into another context, but is meant as a contribution to the field of museum learning and use of novel technology for learning experiences.

4.5.3 My role as a researcher

Through this whole study I have had several roles. Both as a designer for the experiment and its tasks, then as an observing participant during the visit. As a designer for the experiment I was working with my co-researcher, with people from the museum and with the teacher. During the visit I was mostly observing, taking field notes, and sometimes participated in solving practical tasks such as how to control the robot. The task was designed in a way that required all but students conducting the visit to take an observing role. This was done to see how the students took on and solved the given tasks.

I have transcribed all audio-recordings myself, with some help from a native French speaker to ensure correct understanding and translation. The recordings were gone through several times, before deciding on which sequences to analyse. When selecting the sequences, I went through all transcriptions several times, and chose four sequences that illustrate different ways in which the robot, guide and worksheets mediated students' learning and interactions. Concepts from the theoretical were applied in the analysis to identify relevant themes.

5 Analysis

In this chapter I will analyse the data. I am to investigate *the opportunities for learning and meaning making with a telepresence robot in a natural science museum,* by asking two research questions: *How does a telepresence robot mediate learning and interactions in a museum context?* And *In which way do these interactions enhance learning and understanding?*

I start by giving a rich description of the whole 80 minutes session for the museum-visit, based on analysis of the observations and audio recordings of the different groups. In the analytical part I look closer at four sequences extracted from each group. I will analyse all four sequences separately, and then summarise my findings in the end of this chapter.

5.1 Rich description of the visit to Musée des Confluences

In this subsection I will give a rich description of the full 80 minutes museum-visit with the telepresence-robot. This is done to provide the reader with a thorough understanding of the context and how the visit was conducted.

The visit was conducted by a French 5th grade class of 22 students. Before the visit, the class as a whole was given a 10 minutes preparation session in the classroom by the teacher on what was going to happen that day. They were informed that they were going to visit the museum in groups, using a robot, and that they would be given tasks to accomplish during the visit, and after also. Details were given on how they had to structure the visit and divide the work among them such as who is piloting the robot, who is taking notes, and who is controlling the time. Then the groups were given 20 minutes each in the computer lab that was set-up for the visit. In the computer-lab, the groups were each given a worksheet, with one main-task and two additional questions, related to the *Origins* exhibition in Musée des Confluences. These tasks were different for each group (see Appendix 2). The main task involved finding an object in the museum, and the additional questions were either related directly to the object, with answers to be found on-site, or required use of previous knowledge related to the object. There was also a bonus-task that was similar for all the groups, to be

completed after finishing the worksheet. This was a blank map of the *Origins* exhibition room where they were told to try to mark things they were seeing in the exhibition, both during the worksheet-task and when exploring more independently.

All the groups started out by dividing tasks, and deciding turn-taking on controlling the robot. Some of them had already been to the exhibition, and knew where some things were (such as the big Camarasaurus, which is central in the exhibition), while others had not been there at all. Typically the students took turns for about five minutes each, piloting the robot. In group 4 there were two students who did not want to try controlling. All groups started out by looking for the object for their first question from the worksheet, and had some discussions on where and how to move the robot.

The groups moved the robot through the *Origins* exhibition, and found different objects of interest in addition to their main object. For each group the visit included a variety of looking at and discussing objects with each other and with the museum guide, and especially for group 2 and 3 some interactions with other visitors in the museum. All groups spent between 8-12 minutes on completing tasks from the worksheet, and had around 10 minutes each for exploring the exhibition more independently, using the blank map as a coordinator.

Figure 4. Robot in Musée des Confluences.

5.2 Analysis of sequences

In this section I will analyse four sequences extracted from the group's visits. The sequences are analysed grounded in *what kind of interactions or dialogues a telepresence-robot mediates,* and *if these interactions enhance learning and understanding* in the group of students. The analysis is based on findings from earlier research reviewed in chapter two, and my theoretical stance. The theoretical perspective when analysing is grounded in a sociocultural view on learning, put in a museum context by Andersson and Jakobsson's (2012) model of learning and development in science centers and museums, and supported by a dialogical approach to learning (Dysthe, Bernhardt & Esbjørn, 2012). All students, assistant teachers and the museum guide are anonymised through fictitious names. Researchers are mentioned by their real name.

Transcription conventions are adapted from Jefferson's (2004) system for punctuation, grounded in conversation analysis. These are illustrated in the table below.

(( ))	The researcher's own descriptive comments
(number)	Indicates pause, in seconds
-	Indicates sudden stop in, or abruption of speech
[ ]	Indicates overlapping speech
(.)	Indicates a short, unmeasurable pause
(...)	Indicates unclear speech

Table 2. Symbols and numbers for transcription.

5.2.1 Excerpt 1

Members of group 4	Present in the classroom	Present in the museum
Tomas Leyla Gina Gerry Ron Daniel	Hanna-Marie (researcher) Lena (assistant teacher) Jean-Pierre (teacher)	Cécile (researcher) Maya (museum guide)

This group of students is working with a task from their worksheet; to locate a piece of a meteorite, and answer two given questions regarding the meteorite. They have been moving the robot around in the exhibition room, and the sequence starts when they discover the meteorite. Daniel is controlling the robot.

Figure 5. Picture of group 4 during the visit.

1. Daniel: is that a meteorite?
2. Cécile: this one?
3. Daniel: yes, is it a meteorite?
4. Ron: but is it real or is it fake?
5. Daniel: I think it is a reproduction
6. Maya: and why do you think it is a reproduction?

7. Daniel: I don’t think there really is one in the museum
8. Maya: it is a real one, and you can even touch it
9. Leyla: [ooh]
10. Daniel: really?
11. Maya: yes, it is a real meteorite, and it fell down in 1967, in Algeria
12. Daniel: okay (8)
13. Cécile: did you have any questions regarding the meteorite?
14. Ron: uhm, yes, what is the name of the meteorite? ((reading a question from the worksheet))
15. Maya: it’s called Marcel ((laughing))
16. Leyla ((almost whispering)): what was the name of the meteorite?
17. Maya: no, it is called Zerhamra ((spelling)) Ze-rham-ra (3) that was the right answer ((laughs shortly))
18. Leyla ((almost whispering)): how did this meteorite arrive on earth? [5] ((question from the worksheet))
19. Daniel: how did this meteorite actually arrive on earth?
20. Maya: ah, okay, interesting question! So, a meteorite is first part of something larger called an asteroid, okay?
21. ((group mumbling)): okay
22. Maya: and these asteroids circulate between Mars and Jupiter. But sometimes they crash, and then pieces of an asteroid can loosen and be tossed into space, and after millions of year one can go through the atmosphere of the earth
23. Ron: so one hits the other
24. Daniel ((whispering)): I haven’t seen it
25. Maya: exactly, and the piece that finally lands on the ground is called a meteorite
26. Daniel ((almost whispering)): uhmm (...)
27. Maya: what did you say?
28. Daniel ((whispering)): but where was it found? ((reading question from the worksheet))
29. Leyla: Algeria
30. Ron: it was Algeria, wasn’t it
31. Maya: [in Algeria], yes
32. Daniel: ah, that’s true

33. Maya: in the desert in Algeria
34. Ron: in the desert!
35. Leyla ((whispering)): do you think it hurt anyone?
36. Maya: sorry, I didn't understand
37. Ron: did it hurt any people?
38. Maya: I don't know, but I don't think so, it was found in the middle of the desert

This interaction starts with the group finding the object they have looked for, a piece of a meteorite. Daniel asks Cécile if what they are looking at now is the meteorite (line 1-3). Ron joins the conversation by asking if the meteorite is real (line 4). Daniel states that he thinks it is a reproduction (line 5). Maya, the museum guide asks Daniel why he thinks it is a reproduction (line 6), where he replies that he doesn't think there is a real meteorite in the museum (line 7). Maya says that it is real and that it is possible to touch it (line 8), to which Leyla reacts (line 9). Daniel asks if this is really true (line 10), to which Maya replies that it is true, and adds some information on when and where it was found (line 11). Daniel answers okay, and a pause occurs (line 12). Cécile picks up the conversation again, by asking if they had any questions about the meteorite (line 13). Ron answers with one of the questions from the worksheet (line 14). Maya answers while she is laughing, she makes a joke out of it, and does not answer with the real name (line 15). Leyla silently repeats the question (line 16) and Maya answers with the correct name (line 17). Leyla then moves on to the next question from the worksheet (line 18). This creates a pause (line 18) and Daniel repeats the question (line 19). Maya explains how meteorites are created and how they arrive on earth (line 20-22). Ron states what Maya has explained (line 23), and Daniel silently says he hasn't seen it (line 24). Maya confirms Ron's statement (line 25). Daniel poses a question (line 26-28), which is answered by Leyla (line 29). Ron and Maya also answers the question (line 30-31), and then Maya supplies with where it was found (line 33). Ron repeats Maya's answer (line 34). Leyla asks if the meteorite hurt anyone (line 35), and Ron repeats the question when Maya does not hear it clearly (line 36-37). Maya does not think it hurt anyone since it was found in the desert (line 38) and the group moves away from the meteorite.

In this excerpt, the students are working with Maya, the museum guide to get the information needed for answering the tasks from the worksheet. The interaction between this group of students and the guide are characterized by the students asking questions from the worksheet,

and Maya providing them with answers. At the very beginning of this sequence there is a discussion between Daniel and Ron whether the meteorite is real or not. The two of them try to make meaning of the artefact in front of them (Vygotsky, 1978; Andersson & Jakobsson, 2012) and to gather concrete information. However, when Maya provides them with some additional information regarding the meteorite, they do not follow up on this, and Daniel replies with an "okay" and silence. No one else from the group picks up on this either. Cécile enters to drive the conversation forward, and the group replies with reading the two questions from the worksheet. Maya tries to make a joke, and to communicate the answers with enthusiasm, but she gets minimum response from the group. The group of students show little spontaneity, and do not master the dialogical setting and interactions they are encouraged to participate in from the guide and researcher present in the museum (Dysthe, Bernhardt & Esbjørn, 2012). The students in the group seem limited by the novelty of the setting they are in. When creating new learning experiences and introducing novel technology, there is a risk that the experience can be considered "too novel" by the students, and this way become a hindrance, rather than the advantage it is meant to serve as (Pujol-Tost, 2011). In this excerpt, the novelty of the setting seems to decrease both students' motivation and spontaneity in the experience.

However, the students do demonstrate that they are paying attention to what is being communicated from the guide. Ron shows this after Maya's explanation of a meteorite, and tries to make sense of the complex information he is given by reformulating it (Dysthe, Bernhardt & Esbjørn, 2012). Here he is also acknowledging the guide, showing her that he is participating, though passively, in the interaction. There is no flow in the interactions between the students, or between the group and the guide, and the students seem comfortable in the framed setting of the worksheet-task, that puts the visit in a school-like setting, an institutional framework that they are familiar with. The setting with using the robot to visit the museum may be experienced as artificial, they may have little experience with field trips, and they try to make meaning of it by creating a more familiar setting for themselves. At the end of the excerpt, both Leyla and Ron demonstrate again that they have paid attention, by remembering that the meteorite fell down in Algeria. Daniel also emphasizes this after he has been given the answer. This indicates that the students wants to be "good" students, they managed to solve the concrete worksheet task they were given, and completed what was required of them. When it comes to spontaneity, and curiosity the social and dialogical setting seem to be the

biggest hinder for them in exploring further. The students are falling into a familiar setting they are comfortable with, not taking advantage of the opportunities in the setting, but framing it as a school activity (DeWitt & Storksdieck, 2008). This lay both in the design of the worksheets and in the novelty of the setting. Too strict designed worksheets combined with a new setting that this group of students are not comfortable with, can decrease both motivation and learning outcome (DeWitt & Storksdieck, 2008).

The students stick to their role as "good students", and manage to demonstrate that they have received the information, also in the debriefing session two weeks after the visit was conducted. In the debriefing session the teacher asks if the group can explain what a meteorite is. Ron then explains that it burns, and it goes really fast, but that the one in the museum did not hurt anyone when it fell down. This confirms their identity as students (Leinhardt & Knutson, 2004), the learning outcome they show in the debriefing session demonstrates that they have managed to interpret the information they were given during the visit. However, as this discussion shows, this information was passively received. The students did not expand on or engage with the information in a manner that advanced their knowledge or meaning making process, in a strict worksheet design and a dialogical setting for learning that this group struggled to master. Besides the factors mentioned, the strict worksheet design and the novelty of the setting, the social dimension is also important. During the whole experience the students were continuously "watched" by both researchers, teachers and museum-guide. Even though everyone was there to help and observe, this may have led to the students feeling "on display", in a social setting they were already uncomfortable with. The presence of researchers, knowing that they were being recorded and the structure of the setting may have impacted the students' behavior in their group, and contributed to the missing spontaneity and motivation that characterizes a field trip (Falk & Dierking, 2000).

5.2.2 Excerpt 2

Members of group 3	Present in the classroom	Present in the museum
Francois Jean-Luc Alex Anna Amelia	Hanna-Marie (researcher) Lena (assistant teacher)	Cécile (researcher) Maya (museum guide)

This group is also working on a task from their worksheet. The task is to find the mammoth in the exhibition, by asking other visitors for directions. The mammoth is located in a smaller "side-room" of the main exhibition. The talk selected in this excerpt starts as the group has managed to navigate the robot to the room with the mammoth. Francois is controlling the robot.

Figure 6. Picture of group 3 during the visit.

1. Francois: it is not so fast! ((the robot))
2. Amelia: we are here ((pointing to the the blank map of the exhibition room the group have in front of them in the computer lab))
3. Alex: ask these people
4. Francois: hello!
5. Amelia: we need to turn
6. Alex: go!

7. Jean-Luc: [watch out!]
8. Francois: there was a lady, ups ((group laughing))
9. Man in the museum: oh, what is this?
10. Jean-Luc: it was not a lady, it was a man ((group laughing, they do not answer the man))
11. Alex ((in a pretend-voice)): the mammota
12. Francois: but yes, let's ask him about the mammoth! Listen, what do you know about mammoths? ((this is a question from the worksheet. There is lot of noise from people talking in background in the museum, the man does not reply))
13. Alex: but the mammoths they are what, really?
14. Jean-Luc: the mammoths are prehistoric
15. Alex: so then they are already dead
16. Jean-Luc: we cannot see mammoths anymore
17. Alex: and they have fangs
18. Jean-Luc: fangs!
19. Alex: okay, move forward then, ((in a pretend-voice)) accelerate!
20. Francois: it is still not so fast
21. Alex: it's okay, it's moving forward well now
22. Francois: can I not make it go any faster?
23. Hanna-Marie: sorry, you have it on maximum speed now
24. Jean-Luc: [okay], so they have fangs, and they have really long fur

This excerpt starts when the group is in the room exhibiting the skeleton of a mammoth. Francois is commenting that the robot is not so fast (line 1), while Amelia is talking about the map of the exhibition they have been given for the assignment (line 2). Alex sees some people in the museum, and propose to talk to them (line 3). Francois says hello (line 4) Amelia states that they need to turn (line 5), Alex joins in on this (line 6) while Jean-Luc shouts to watch out (line 7). Francois says there was a lady in the museum (line 8), and then a man asks them what this is (line 9). Francois says it is a man, not a woman and the group laughs (line 10). Alex is shouting out about the mammoth (line 11), and Francois proposes to ask the man in the museum about their given task (line 12). The man does not reply, and Alex asks what a mammoth really is (line 13). Jean-Luc answers that they are prehistoric (line 14), and Alex replies that they are already dead (line 15). Jean-Luc says we cannot see mammoths any more

(line 16). Then Alex states that they have fangs (line 17), and Jean-Luc repeats this (line 18). Alex goes back to talking about the movements of the robot (line 19), to which Francois replies that the robot is still not so fast (line 20). Alex says that the speed is okay now (line 21), but Francois asks Hanna-Marie if it cannot go any faster (line 22-23). Jean-Luc sums up what they have said about the mammoths (line 24).

The first thing we notice in this sequence is the involvement with orienting the robot in the exhibition. Francois is concerned with the speed of the robot, while Amelia and Alex are focused on the task of navigating and orientation and of solving their worksheet task. In this group, navigating the robot is a collaborative task and seems to be the focus and engagement of the group. Visiting the exhibition with the robot requires the students to find new ways to engage with the artefacts (Andersson & Jakobsson, 2012) as several visual clues occurring in a typical field trip visit are gone, such as signs and limited vision field. Navigating the robot is bringing this group together, and is a fun, novel and engaging collaborative activity that has meaning itself as a social experience (DeWitt & Storksdieck, 2008).

Considering their way of navigating and their collaborative engagement around this a novel activity also brings up the question on how this differs from a typical visit to a museum. This group was assigned a task that required them to interact with other visitors in the museum. Francois brings this further, when he wants to ask a man in the museum about their next worksheet task. Normally, asking a stranger questions this way when visiting an exhibition would be considered the exception rather than the standard. It is interesting then, to look at what kind of interactions the robot introduces. For this group, it seems like the robot as an avatar allows them to break the barrier it normally is to talk to strangers in a museum exhibition (Ramon-Vigo et. al, 2016).

Considering the navigation of the robot as a fun and novel activity, I would also like to draw on another perspective. In this setting, navigating the robot is integrated in the learning activity that is framed by the visit and their given tasks. The robot becomes the mediator that actually allows them to be immersed in the exhibit, and navigating it is a natural part of "looking activity" and exploring that is the foundation for meaning making activity in museums (Falk & Dierking, 2000). This way, the robot help the students in collecting and processing information from the exhibition, it becomes the center of a collaborative effort and

engagement in the group, and what it mediates lays the foundation for meaning making interactions and dialogues regarding the artefacts in the exhibition. This type of meaning making interaction occurs in this sequence, when Alex is wondering what mammoths really are. In this dialogue Jean-Luc and Alex build on each other's knowledge, and create a dialogue that drives learning forward (Dysthe, Bernhardt & Esbjørn, 2012). It is clear that they both have some previous knowledge and manage to add this to the setting. Jean-Luc and Alex are using what they observe in the exhibition through the robot, and their previous knowledge of mammoths to make sense of the mammoth as an artefact (Crowley & Jacobs, 2002; Wertsch, 1991).

5.2.3 Excerpt 3

Members of group 2	Present in the classroom	Present in the museum
Malia Lisa Ina Emma Rachel	Hanna-Marie (researcher) Sofia (assistant teacher) Jean-Pierre (teacher)	Cécile (researcher) Maya (museum guide)

This group has finished their questions from the worksheet. They are now navigating the robot around, exploring the exhibition. We enter this sequence when the group is discussing what to look for, and end up by a dominating mural of aboriginal paintings in the exhibition. The group just switched pilots, and Malia is controlling the robot.

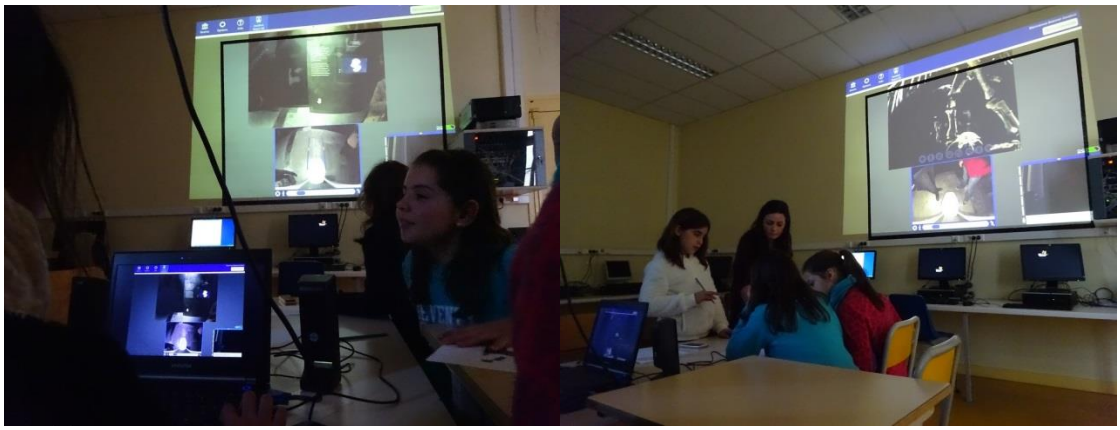

Figure 7. Picture of group 2 during the visit.

1. Maya: hello
2. Malia: hello!
3. Rachel: but how do we do now?
4. Ina: maybe we can ask some more questions
5. Malia: oh, sorry ((loud background noise from people talking in the museum)) uhm, excuse me!
6. Ina: ((shouting)) [excuse us!] ((group laughing))
7. Cécile: ((laughing)) okay, do you know what you are looking for now?
8. Malia: uhm, no (.) I am just looking, but -
9. Rachel: let's find something

10. Emma: can we only be in this room?
11. Hanna-Marie: yes, you can move around only in this room
12. Malia: okay, what are we interested in?
13. Rachel: what is that over there?
14. Malia: I have seen that
15. Ina: [that is] the big dinosaur (3)
16. Rachel: what if we go there, to the left?
17. Malia: okay, I wanna see that thing over there (.) what is this we are looking at?
18. Maya: this is an aboriginal painting
19. Malia: but what is an aboriginal painting? ((group laughs, she pronounces it wrong))
20. Maya: it is a painting made of the aboriginal people, who lives in Australia
21. Malia: ah, do they still exist?
22. Maya: yes, they still exist
23. Malia: okay
24. Ina: but you have to turn!
25. Malia: no, but let's see (.) I want to see this (.) what is this thing?
26. Maya: this is still an aboriginal painting
27. Malia: oh (.)
28. Maya: do you see this big snake over here?
29. ((mumbling from the group)): uhm, yes
30. Maya: this one is called the Rainbow snake. It represents the beginning of life
31. Malia: [ah]
32. Maya: for the aborigines
33. Rachel: it is really cool to see this or what
34. Emma: I really like it (.) I would like to go back to the Musée des Confluences to see this one
35. Rachel: I haven't seen the snake
36. Emma: but you can go back and see it for real
37. Rachel: no, but I have seen it now, I will tell the teacher that

This interaction starts when the group is exploring the museum. They have just found a mural with aboriginal paintings. Maya and Malia starts by greeting (line 1-2). Rachel asks what to do (line 3), to which Ina replies that they can ask some questions (line 4). Malia is controlling

the robot, and tries to move past some people in the museum (line 5). Ina shouts at the people in the museum, and the rest of the group and Cécile laughs (line 6-7). Cécile asks if they are looking for something particular (line 7), to which Malia replies no (line 8), and Rachel wants to find something (line 9). Emma asks if they can only be in the *Origins* room, to which Hanna-Marie replies yes (line 10-11). Malia asks the group what they are interested in looking at (line 12), and Rachel says to look at something (line 13), to which Malia replies that she has already seen it (line 14). Ina states that it is the big dinosaur, which they have seen earlier in the visit (line 15). Rachel and Malia decide to look at something, and ask what it is (line 16-17). Maya explains that it is an aboriginal painting (line 18), and Malia wants to know what an aboriginal painting is, but struggles to pronounce it, and the group laughs (line 19). Maya then explains who the aborigines are (line 20), Malia asks if they still exist, Maya answer that they do and Malia says okay (line 21-23). Ina says they need to turn, but Malia wants to look at something, and she asks again what they are looking at (line 24-25). Maya replies that it is still an aboriginal painting (line 26) and Malia states a short oh (line 27) before Maya goes on explaining the painting. Maya asks if everyone can see the snake on the painting, which they can, and Maya explains the meaning of it (line 28-32). Rachel says that it is really cool (line 33), and Emma says she would like to go see it in the museum (line 34). Rachel says she hasn't seen the snake (line 35), and Emma tells her she can go see it "for real" (line 36), to which Rachel replies that she has seen it now, and wants to tell the teacher that (line 37).

When exploring, Rachel wants the group to agree on what they should do now that the worksheet is finished. Ina suggests to follow the path from the worksheet, by asking more questions. The first part of the sequence is spent on such suggestions from Rachel and Ina, focusing on the group coming to a collaborative agreement on what to do next with the robot and the exhibition (Stahl, Koschmann & Suthers, 2006). Malia supports this by asking what are *we* interested in. When exploring freely, the group is guided by the room and the artefacts of the exhibition (Falk & Dierking, 200; Andersson & Jakobsson, 2012).

It is not until Malia asks a specific question, about what the mural of the aboriginal paintings is, that Maya, the museum guide enters the conversation. Before the visit she was instructed to be led by the students, not the other way around, and this characterizes her behavior during the whole visit, but becomes specifically clear in this sequence. The reason for this instruction

is that I wanted the students to be the investigators, to be able to explore based on their own decisions (Falk & Dierking, 2000) and to be guided by the artefacts in the exhibition, not by a guide taking them on a tour. This allows for the students to investigate, explore and be curious (Gutwill & Allen, 2012). Even when asked specifically, Maya provides the group with minimal information, allowing Malia to reflect and to come up with new questions. Malia needs to ask specifically what an aboriginal painting is, for Maya to provide her with some more information. Malia also tries to relate the information she gets by asking if the aboriginals still exist today. The dialogue between Malia and Maya is interrupted by Ina, but Malia wants to explore the mural further. When the rest of the group starts paying attention, Maya explains the meaning of the pictures in the mural, and this way is adding layers of knowledge to the dialogue she already had with Malia (Dysthe, Bernhardt & Esbjørn, 2012).

In this part of the sequence, the presence of the robot is at a minimum. The group seem to handle the navigation well, and the interactions are not framed by the fact that the group of students and Maya are not physically in the same room in their conversation. However, in the last part of the sequence, the discussion between Emma and Rachel points to an interesting perspective of the exploration of the exhibition through a robot. Rachel express enthusiasm over the mural, but in contrast to Emma, she has never been to the Musée des Confluences. Emma tells Rachel that she can go and see it "for real", but then Rachel states that she has seen it now, and that is something she will tell the teacher. This brings us to an interesting discussion of the whole experience with seeing the exhibition through a screen. It is not digital, as it is a real-life and real-time setting, but it is clear that for Emma it is still not the same as seeing it in the museum. This demonstrates how the use of such technology blurs out the lines of our physical space (Pujol Tost & Economou, 2007) and makes us think in new directions to reflect on what we just have experienced. Considering the interaction between Emma and Rachel this way, we can say it also contributes to the development of skills that goes beyond factual knowledge, such as process skills and affective skills that are considered just as important feature of a field-trip experience (DeWitt & Storksdieck, 2008).

5.2.4 Excerpt 4

Members of group 1	Present in the classroom	Present in the museum
Oscar Pierre Martin Teresa Aurelie Florence	Hanna-Marie (researcher) Sofia (assistant teacher)	Cécile (researcher) Maya (museum guide)

The group has finished their worksheet task, and is now moving the robot around exploring the exhibition. They are navigating the robot in a part of the exhibition containing fossils and creatures from the sea. Florence is controlling the robot.

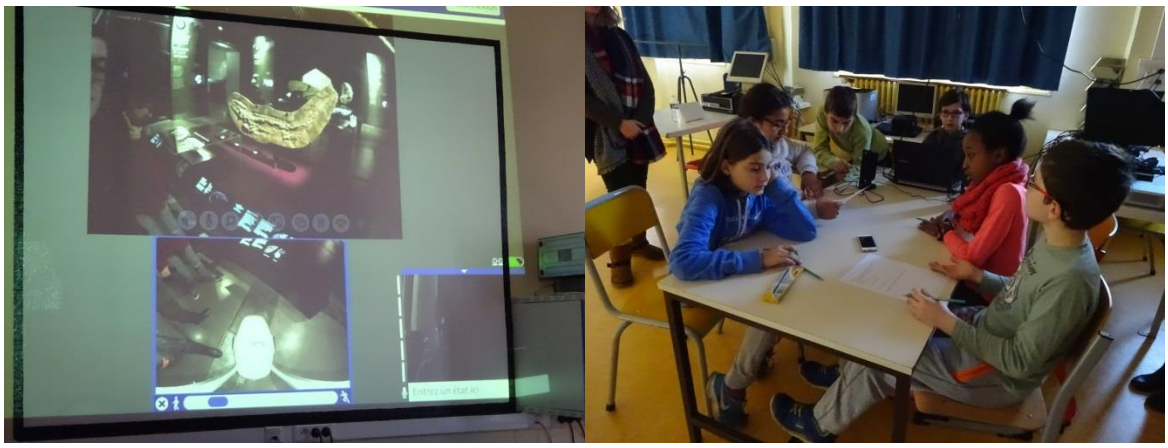

Figure 8. Picture of group 1 during the visit.

1. Aurelia: what is this over here?
2. Pierre: but turn around
3. Martin: what is it?
4. Teresa: I haven't seen it
5. Pierre: but turn around ((laughter from the group)) go!
6. ((The whole group shouting)): go, go!
7. Aurelia: watch out for the lady! ((group laughs))
8. Pierre: no, crash into her!

9. Maya: what are you looking for now?
10. Teresa: a dinosaur
11. Aurelia: we have seven minutes left
12. Oscar: [but] what is the one behind you?
13. Maya: this one?
14. Pierre: that is the diplo, no the camaro, camaro, camarasaurus ((group laughs, it is hard to pronounce))
15. Maya: yes, you have already seen this one
16. Aurelia: okay, turn ((group laughs))
17. Teresa: to the right
18. Pierre ((in an eager voice)): [to the right]
19. Oscar: there is another skeleton, or something brown
20. Florence: maybe it is a T-Rex
21. Aurelia: I cannot see it
22. Martin: [next to it, next to it!]
23. Teresa: I think it is a T-Rex
24. Florence: should I back up?
25. ((The whole group shouting)): noo!
26. Florence: okay, how do I raise the head? ((point the camera upwards))
27. Oscar: use this one, and then you do this (.) ((demonstrates how to control the robot))
28. Pierre: now we can put down two crosses ((talking about the map of the exhibition))
29. Maya: ok, can you see it now?
30. Florence: yes, but what is it?
31. Maya: this is called a mosasaur ((mosasaurus in English))
32. Pierre: a mosasaur? ((group laughs)) (.) ((spelling)): mo-sa-saur ((group laughs))
33. Oscar: but this is not a dinosaur, it is a reptile! It is not the same (.)
34. Maya: yes, it is a reptile, not a dinosaur

This interaction starts with Aurelia who sees something, and wants to know what it is (line 1). Pierre says to turn around (line 2), while Martin asks what it is (line 3). Teresa says she hasn't seen it (line 4), and Pierre demands again to turn around (line 5). The whole group starts shouting go (line 6). Aurelia says to watch out for a lady in the museum (line 7) while Pierre says to crash into her (line 8). Maya asks them what they are looking for, to which Teresa

replies a dinosaur (line 9-10). Aurelia states that they have seven minutes left (line 11). Oscar asks about something behind Maya (line 12), and she asks which one (line 13). Then Pierre says that it is the Camarasaurus that they have seen earlier in the visit, which Maya confirms (line 14-15). Aurelia then says to turn, and Teresa and Pierre both says to the right (line 16-18). Oscar sees something in the exhibition (line 19), and Florence thinks maybe it is a T-Rex (line 20). Aurelia cannot see it (line 21), and Martin says next to it (line 22). Teresa also think it is a T-Rex (line 23). Florence asks if she should back up, but the group answers no (line 24-25). Then she asks how to raise the head of the robot, and Oscar shows her on the laptop (line 26-27). Pierre says to put down two crosses at the map of the exhibition (line 28). Maya asks if they can see it now, to which Florence replies yes and asks what it is (line 29-30). Maya tells them what it is, and Pierre tries to spell the name while the group is laughing (line 31-32). Oscar states that it is a reptile, not a dinosaur, which Maya confirms (line 33-34). The group then moves on to a bigger collection of fossils.

When we enter the sequence, this group is also focused on navigating the robot. The have finished their worksheet task, and are now exploring the museum, and trying to make a collaborative decision on what to see next. Pierre is the one making the final decision, in which the group joins in to move forward. When hindered by some visitors in the museum, Maya steps in with an open question to steer the group's focus back on the exhibition (Andersson & Jakobsson, 2012). The next sentences illustrate the variety of tasks the students were able to handle during the visit, engaging with the exhibition and the guide, navigating the robot and performing tasks in the computer lab such as controlling the time (Stahl, Koschmann & Suthers, 2006).

When trying to pronounce the name of the Camarasaurus, Pierre is first referring to the "diplo", another similar dinosaur in the same family. Maya emphasizes that they have already seen this one, and the group continues their collaborative dialogue on where to move next (Dysthe, Bernhardt & Esbjørn, 2012). When exploring the exhibition, the group is driven by the artefacts embedded in it (Andersson & Jakobsson, 2012). Oscar makes an observation of "a skeleton, or something brown", and Florence immediately makes an effort to relate this to the experience they already have had in the exhibition, and also shows that she has some previous knowledge regarding other types of dinosaurs that are not found in the exhibition

(Crowley & Jacobs, 2002). Teresa supports her view, and makes a more secure statement, building on Florence's approach (Dysthe, Bernhardt & Esbjørn, 2012).

Florence is the one controlling the robot, and when Aurelia says she cannot see the robot, she needs help to position the robot so that they can all see the dinosaur they think is the T-Rex. The group is again demonstrating their interactive and collaborative approach to the task (Säljö, 2001; Wertsch, 1998), and while Oscar helps Florence with the navigation task, Pierre is focused on the exhibition map in front of them. Again Maya demonstrates here her role as a supportive tool, as she let the group figure out all their obstacles, and do not interfere until the group has positioned the robot in a way that makes it clear they can now see what she is seeing. When the group ask a specific question on the artefact they have observed, she provides them first with the name, and allows the students to think of the name. Pierre is making fun of the pronunciation, and this may be a way for him to make sense of what he is seeing, and also a way of communicating or enter a discussion with the group (Andersson & Jakobsson, 2012; Wertsch, 1998). Oscar takes up the dialogue from Maya, using what is clearly his island of expertise (Crowley & Jacobs, 2002). He demonstrates specific knowledge in the area of dinosaurs and fossils, being able to separate the two when being presented with the name (Crowley & Jacobs, 2002; Andersson & Jakobsson, 2012).

5.3 Summary of the Excerpt Analysis

Based on my analysis of the excerpts from my data collection, I have identified three areas that I consider of importance to address the research questions. These areas are; *worksheet design, social setting* and *navigating the robot*. In this subsection I will elaborate and summarise these areas, and why I consider them crucial for the learning experience taking place in the museum and classroom with the telepresence robot.

The role and design of worksheets and tasks impact the structure and experience of the visit (DeWitt & Storksdieck, 2008). What becomes clear especially in Excerpt 1, but also in Excerpt 2, is the strict design that lies in the worksheets. The tasks given in excerpt one are closed, fact based questions, which made it easy and comfortable for this group to stay in a familiar, school-like setting, where they could seek up answers and note them down. This fosters minimum spontaneity, and the free-choice learning is replaced by a school-framing

(Falk & Dierking, 2000). For the group in Excerpt 1, the worksheet design did not engage them in the task, and did not manage to foster or enhance their curiosity. This may have impacted their motivation for the visit (DeWitt & Storksdieck, 2008), and restricted them in their engagement with the task. Another influencing factor is social setting the students are facing. The group in Excerpt 1 struggled to enter the novelty of the experience (Pujol-Tost, , and were comfortable with their group-identity as good students (Leinhardt & Knutsson, 2004). However, a corresponding factor for all the four groups is that there are 2-3 students who are clearly more active than the rest of the group. This may impact the group in the way it did with the group in Excerpt 1, that all members seek a common identity and becomes passive, or as we can see in excerpt three that one student sometimes represent all the dialogue and decision making. This indicates that task design needs to take group composition and social setting into account, and also that there is a limitation within the robot that it maybe works better in smaller groups.

Also influencing the social setting is the area of previous knowledge. In any experience, in our everyday life and in interactions with our surroundings, we enter with a set of norms, rules and understandings that shapes our conception of the situation we are in. As humans, we are shaped by our interactions with each other and through our social and cultural environment (Vygotsky, 1978; Wertsch; 1991). In new experiences, relationships and engaging with artefacts we learn and develop ourselves, and shape our view of the world. Considering this view on learning as something constantly occurring in everyday settings, and in arranged settings such as school or a field trip, previous knowledge and experiences impacts the outcome of an experience (Vygostsky, 1978; Crowley & Jacobs, 2002). As we see especially in Excerpt 2 and 4, the students bring in their previous knowledge to make meaning of the artefacts in front of them, and of the setting they are in. Especially in Excerpt 4, the discussion from two of the students are driven by what seems to be their islands of expertise, involving a broad knowledge of dinosaurs and related species. When involving previous expert-knowledge, and relating this to new experiences, the students take an active part in their own meaning making process (Vygotsky, 1978), and their learning experience is driven by their surroundings and their engagement in it (Andersson & Jakobsson, 2012).

Navigating the robot in the exhibition is a crucial part of the experience. As we can see especially in Excerpt 2 and 4, moving the robot around can be a fun experience just in the

novelty of it, but also positioning the robot to get a good view on the artefacts in the exhibition is of great importance. The robot has its limitations in turning range and angle both upwards and sideways, that requires navigation from the pilot and, as we can see, support from the other group members on how to position it, turn the head up or down, decide on direction to see or go where they wish. This limits e.g. reading signs and posters in the museum, and requires the group to seek out information in new ways, in contrast to visiting the exhibition in person. Considering this, the museum guide has a central role, when conducting this visit. Based on the idea of free choice learning and exploration (Falk & Dierking, 2000) the guide was told to act as a support for the students, keeping in the background, but always available whenever the students had questions. This role becomes clear especially in Excerpt 3 and 4, where there are long dialogues between the students, and the guide does not enter until specifically addressed. The guide still acts as the main source of information, because of the viewing limits in the robot, but this way the solving of tasks and learning experience becomes social and dialogical (Wertsch, 1991; Dysthe, Bernhardt & Esbjørn, 2012).

5.3.1 Summary of Analysis

In this chapter I have analysed four excerpts from my data collection. The sequences are analysed based on earlier research on the field of museum learning and technology, and my theoretical stance in a sociocultural perspective on learning. Analysing the sequences is based on the method of interaction analysis (Jordan & Henderson, 1995) that allowed me to identify important features of the verbal and nonverbal situations in the excerpts that influence the learning experience. Based on my analysis on each of the four excerpts, I have identified three areas that I consider of importance for student's learning outcome. These areas are; *worksheet design, social setting,* and *navigating the robot*. In chapter 6 I will discuss these key findings in greater detail.

6 Discussion

In this chapter I will discuss my findings, in light of relevant theories and research presented earlier in this thesis. In this section I will also refer to interviews with teacher and the museum guide, to a questionnaire that was conducted by the students right after the visit, and to the debriefing session held two weeks after the visit to Musée des Confluences with the telepresence robot. I aim to investigate *the opportunities for learning with a telepresence robot in a natural science museum*, by asking "*How a telepresence robot mediates learning and interactions in a museum context?"* and "*In which way do these interactions enhance learning and understanding?".*

Starting this project, I wanted to seek out the opportunities for learning outside of school with novel technology, represented by the telepresence robot. Focus was on learning through engagement, experience and interactions. In the questionnaire answered by the students after the visit, a recurring comment was regarding the social interactions, both within their group and with other visitors. A boy answered that he was surprised of a boy saying *"hello robot"* to him, and that people *"wanted to look at us"*. In the debriefing session another boy stated that *"it was cool to be in a group, so we could laugh when we talked to people in the museum"*. This emphasizes the visit as a social, fun and collaborative activity (DeWitt & Storksdieck, 2008). When asked how this visit differs from visiting an exhibition in person, there was a common agreement in the questionnaires that this was the experience of being two places at once. A girl states that *"It is really incredible, because we were not another place but in school, and thanks to a robot we were there at the same time. It is almost unimaginable. I loved the visit to the museum, it is like we have actually been there"*. I consider this an important part of the experience, to discover the novelty of such experience and to reflect on this as a part of the learning process (DeWitt & Storksdieck, 2008). It also becomes clear that even though they differ between seeing it "in real life" and through the robot, the line between this become blurry, as discussed in excerpt three in my analysis chapter. Through technology, classroom walls disappear and open up for new experiences. It is also important to point out that the limits of conducting such visit also was mentioned, such as stated by this girl; *"It was really hard to see things sometimes, and we could not touch them or take photos".*

Both the museum guide and the teacher were positive to the experience, both as an engaging and learning activity. For the teacher, the possibility of blurring out the classroom walls and discovering new ways of receiving, exploring and gathering new information was a crucial part. He states that the experience itself has value, just for the novelty and engagement in it, but that it also had valuable curricular and social outcomes for the students. The museum guide pointed to the fact that except from communicating through a robot, the students were like kids are when they visit the museum on a regular field trip; curious and explorative stating that *"they are drawn to everything that's around them".*

Based on my analysis of data above I have defined three areas I consider to impact the learning and meaning making experience for the students when visiting the museum with a robot: worksheet design, social setting and navigating the robot. I will now go further into each of these areas, relating my findings to previous research and the theoretical framework.

6.1 Worksheet design

In Excerpt 1 and Excerpt 2, students are working with tasks from their worksheet, and it becomes clear especially in the first group, that the design of the worksheet does not encourage their curiosity. This group of students show little interest and spontaneity in the tasks they are given, and responds by noting down the answers and moving on to the next task. The questions given are closed, fact-based questions, making it easy for the group to stay in a familiar school-like setting (DeWitt & Storksdieck, 2008), where they do not have to challenge themselves. Previous findings shows that strict worksheet design and closed tasks can reduce students motivation, restrict exploratory behavior, and focus attention of the students primarily on finding the facts required, not exploring the exhibition or artefacts (Hauan & Kolstø, 2014; DeWitt & Storksdieck, 2008). Learning in museums is based on the opportunity of free exploration, and free choice learning (Bamberger & Tal, 2007; Falk & Dierking, 2000) and findings from Excerpt 1 indicates that design of the worksheet is too strict for the students to be able to enter the area of free-choice learning. However, research show that a complete lack of structure can be frustrating for the students, and more importantly, that lack of structure did not foster learning related behavior (Bamberger & Tal, 2007). Considering this, implications for design of worksheets, and of field trips as a whole,

need to include opportunities for free exploration, structured in a setting that makes the knowledge gathered meaningful for the students.

As worksheets are a frequent tool when conducting field-trips, it is important to seek out the possibilities and limitations that lies within the use of these. In this study, students from the first group were restricted by too controlled frames for their experience with the robot and the exhibition, and research shows that such strict design can be counterproductive for learning (Bamberger & Tal, 2007). The group in Excerpt 1, managed to use the worksheet as it was designed, meaning that the restriction lies in the design. Designing worksheets that generate discussion in the group of students is thus essential, to facilitate free-choice learning and exploration that fosters reflection grounded in the social setting and reflection occurring in the group (Hauan & Kolstø, 2014; Wertsch, 1991). Designing worksheets with open-ended questions can facilitate for skills such as critical thinking, reflection and discussion to develop, enhancing the students learning and collaborative meaning making process.

When designing educational activities in museums, teachers and museum practitioners need to include both freedom of choice and structure, framed by tasks that facilitate both personal motivation and at the same time focus on relevant concepts, activities and observations (Hauan & Kolstø, 2014). Bamberger & Tal (2007) conclude that activities in museums should allow controlled choices. This illustrates the opposites of strict design and free exploration, and the importance of finding a balance between these when designing worksheet tasks. In the case of this study, worksheet design was too strict, and became a hindrance for students' exploration and opportunities for discussion. When using worksheets as a tool, the design of the whole experience of visiting an exhibition also needs to be taken into account, to provide an appropriate amount of free choice learning (Falk & Dierking, 2000) and structure that facilitates and sparks curiosity and engagement within the students.

6.2 Social setting

In this study, the focus is on learning through social interaction and dialogue (Dysthe, Bernhardt & Esbjørn), and factors such as group composition and its social dimension has been taken into account to foster meaningful experiences for all students. I will discuss the social setting of being in a group of students, and consider collaborative meaning making and

the role of the museum guide as important factors mediating the learning and understanding in all of the groups. In a sociocultural perspective, learning occurs when we engage with our surroundings, with other humans and with mediated artefacts through psychological tools such as language or through our physical world (Vygotsky, 1978; Wertsch, 1991). Considering this, the social setting when creating learning experiences is of great importance.

Working in groups requires the students to possess certain skills such as collaboration, turn-taking, and listening. In addition, this visit required the students to master several technical tasks at once; they have to control the robot and navigate in the exhibition, they have to pay attention to their worksheet-tasks and to what is going on in the museum, and also watch the time they have left. Also, the setting puts them "on display" in the way that teacher, researchers and the museum guide is there to follow up their requests. This requires collaboration, group-coordination and both a technical and social overview of the situation, and some groups master this better than others. Especially for the group in Excerpt 1 the social situation seems overwhelming. They are unsure on how to approach the tasks, and the group shows that they are not comfortable, nor able to master the situation. The questions they ask are often unclear outspoken, or even whispering and they stick to the worksheet questions, with little interest in discussing the answers they are given. The familiar role as passive students and receivers of information reflects a strong identity in this group (Leinhardt & Knutsson, 2004). They are not able to change roles from the traditional school-setting, over to an investigative free-choice learning situation (Falk & Dierking, 2000) and become uncomfortable when encouraged to do so. The group's engagement with the artefacts, with the guide and with each other becomes static (Andersson & Jakobsson, 2012). However, there is a chance that the novelty of the setting is serving as "too novel" for the students, and that this is decreasing their motivation and spontaneity (Pujol-Tost, 2011)

On the other hand, the other three groups seem to master both the technical and social tasks on a higher level. Especially in Excerpt 3 and 4, the students have statements such as "what are *we* interested in" and "where do *we* want to go". DeWitt & Storksdieck (2008) argues that both cognitive and affective skills should be part of a field-trip learning experience, and it becomes clear in the excerpts from these groups and in the debriefing session that this shared experience had a positive effect on the students. Considering these of equal importance, affective skills such as collaboration, sharing of knowledge and engagement are included in

the learning process, and allow students for deeper learning than through curricula-oriented experiences alone (DeWitt & Storksdieck, 2008; Stahl, Koschmann & Suthers, 2006).

6.2.1 Collaborative meaning making

Learning is a complex process, and collaborative learning is influenced by factors such as motivation, roles, language, group dynamics and previous knowledge (Soller et. al., 2005). The role of previous knowledge becomes clear in Excerpt 2 when the boys are discussing the mammoth, but is really shown in Excerpt 4. Two of the boys there demonstrate their island of expertise (Crowley & Jacobs, 2002) on dinosaurs, and use this to elaborate, discuss and create meaning of what they see in the museum (Crowley & Jacobs, 2002; Andersson & Jakobsson, 2012). One of the boys also demonstrates this again in the debriefing session by relating the Camarasaurus they saw in the museum to another dinosaur, stating that it is the cousin of the Diplodocus, a name and species that he brings into the discussion. Being able to bring previous knowledge into new areas, to create links and meaning is referred to as conceptual learning (Hauan & Kolstø, 2014). Conceptual learning involves exploring and identifying possibly relevant prior knowledge, to provide an anchor point for new ideas and learning (Hauan & Kolstø, 2014). By bringing in his previous knowledge on dinosaurs, the boy from Excerpt 4 is identifying his prior knowledge, and brings in a new topic for further exploration that can serve as a foundation for further project work on dinosaurs. This learning process also involves active exploration, discussion and experimenting, making it appropriate for the free-choice learning taking place in museums (Falk & Dierking, 2000; Andersson & Jakobsson, 2012). Research also shows that students tend to connect previous knowledge to new experiences, whether this is encouraged or not (Crowley & Jacobs, 2002; Bamberger & Tal, 2007). This way, previous knowledge becomes a factor that impacts the group's collaborative learning, and contributes to a rich learning environment of discussion and engagement (Dysthe, Bernhardt & Esbjørn, 2012; Stahl, Koschmann & Suthers, 2006).

6.2.2 The role of the museum guide

When discussing this project with the museum guide, it was made it clear that her role was to be passive. Meaning that the tour was not led by her, but she was to be led by the students, and work as a supplemental source of information, especially since things like reading signs are hard to do from the robot. In all four excerpts, the guide keeps in the background, she only

steps forward when directly addressed with questions, and allows for the students to explore and figure out things on their own before turning to her. This is especially shown in Excerpt 4, when the group spends a long time positioning the robot. Allowing such explorative processes requires the students to be active in their own learning, with the guide serving as a more knowledgeable supervisor (Vygotsky, 1978). To foster conceptual learning, the guide needs not only to provide information, but also engage the students, and allow for them to explore, what is referred to as *guided exploratory learning* (Hauan & Kolstø, 2014). The combination of structure and free-choice learning, scaffolded by the guide, allows the students to control their learning, and this way enhances deeper engagement and involvement in their own learning process (Bamberger & Tal, 2007). If the guide manage to combine a semi-structure of such visit with open-ended questions, and a guided exploratory learning approach, students are allowed to explore, connect their previous knowledge and become engaged in their own learning, and this way create meaning scaffolded by the museum guide (Vygotsky, 1978). By taking her role both as a passive observer, but also as the students main source of gathering information around the artefacts, the guide and the students are equal parts in the co-construction of knowledge and meaning making process that takes place in the museum (Dysthe, Bernhardt & Esbjørn, 2012). When students are contributing with their questions, and the guide with her answers, they enter a dialogue based on what they see in the museum, but also based on what the students bring into the dialogue in terms of previous knowledge and cultural heritage (Dysthe, Bernhardt & Esbjørn, 2012).

6.3 Navigating the robot

Placing a telepresence robot in a museum, and having a school-class conducting a field trip with it, can be seen as an example on the shift of paradigm that has been, and still is going on in the museum-field. This shift of paradigm is characterised by the implementation of technology, such as videoconferencing, virtual reality and museum robotics (Roussou et. al., 2000; Barbanell, Newman & Falco, 2003). In this study, navigating the robot is represented in interactions in all the four excerpts, and what becomes clear is that navigation is a collaborative task. Navigating the robot in the museum, positioning the robot so that all members of the group can see what they want to explore, and the fun of making it go faster or turning around, are all examples that are driven by the group and not only by the student piloting the robot. Through the robot the students experience the museum exhibition from

their classroom, representing a novel way of using technology as a tool of exploration outside of the classroom (Roussou, 2000). Navigation is essential for the student's experience, in the way that the activity itself is engaging, and opens up for discussion and collaboration, but also in its limitations. On one hand, the robot allows for the experience to take place at all, it blurs out the classroom walls and provides students with an activity that fosters reflections on such as if they have seen objects in the museum "for real" or not, and engages them in collaborative tasks. On the other, two students mention that it was hard to see things, that they could not touch them or as one stated in the questionnaire "*we did not always know where to go"*. Mastering the navigation task is essential for the learning experience, and is influenced by group dynamics. When designing for experiences like the one in this study, the fact that navigating the robot is a novel and engaging meaning making activity on its own should be taken into account (Roussou et. al, 2000), but also the limitations that lies within the use of it that hinders typical museum activity, such as reading texts or exploring the exhibition based on visual effects that may not be as clear when piloting the robot from a remote site.

7 Reflections

When I started my work on this thesis, my goal was to investigate how conducting a field trip with a telepresence robot could present new opportunities for learning in a natural science museum. The museum is traditionally designed for, and considered an arena of physical presence to engage with artefacts presented in the exhibitions (Roussou et. al., 2000). A telepresence robot can bring visitors into museums from all over the world, and my aim for this study was to investigate how such technology could be used for extending the classroom, bridging informal and formal learning institutions, and act as an engaging and novel learning activity (DeWitt & Storksdieck, 2008). Previous research show that conducting a field trip, and the learning outcomes of it is influenced by factors such as structure, design, presence of a guide and opportunities for exploration and engagement for the students (DeWitt & Storksdieck, 2008; Falk & Dierking, 2000). When presenting the study for the teacher, his main concern was that the students would be hindered by technical issues, and that struggles with navigating the robot would restrain the students from exploring the exhibition. Being able to discover, experience and master the opportunities of rapid technological development is considered a crucial skill for 21st century learners (Soller et. al., 2005). Findings in this study show that navigating the robot was something all groups mastered. I consider the collaborative navigation of the robot to be an engaging experience, bringing the group together, and serving as a fun, novel activity that motivates the students for further exploration of the artefacts in the exhibition (DeWitt & Storksdieck, 2008). Being a collaborative effort, navigating the robot is a social and interactive activity, mediating artefacts in the museum and framing the learning experience for the students (Wertsch, 1991). Through dialogue within the group, evolving around the artefacts in the museum and mediated by the robot, the students create collaborative and social meaning making experiences driving learning and understanding forward (Dysthe, Bernhardt & Esbjørn, 2012; Vygotsky, 1978).

In this study I consider curriculum skills and affective skills learned to be of equal importance. By visiting the museum with a telepresence robot, the students were tested on collaborative skills such as turn-taking and group-effort when navigating to solve their tasks that would give them curriculum-relevant answers (DeWitt & Storksdieck, 2000). To create meaningful learning experiences in the 21st century is not about memorising facts. Learning

is a continuous process taking place in all human activity, when we engage with others and with our surroundings (Vygotsky, 1978). To learn as humans is to create meaning with others, and to be able to relate knowledge gained on both formal and informal learning arenas, and put these into a greater context. Developing 21st century skills is not about memorizing curriculum for tests, but to develop critical thinking and reflection, and foster skills such as collaboration and creativity (NOU:8, 2015). The world is evolving faster than ever, and technology provides us with unique and novel ways of learning, when used properly (Roussou et. al., 2000). This study aims to contribute to the world and future of using telepresence robot to extend classroom walls, to connect museum and classroom, and to change the way we think about field trips and traditional museum-visits.

7.1 Implications for practice and further research

This thesis is based on a project conducted in a natural science museum with a telepresence robot controlled from a remote site, in a fifth grade classroom. Considering this, the data collection in this study is quite narrow. The size of this thesis also made it necessary to select a smaller sample of the data collected, presented in excerpts from each of the groups conducting the visit. All findings presented in this thesis are based on this data selection, and it is therefore not possible to draw any general conclusions representable for all museum and classroom practices. However, the findings in this study may serve as indicators on factors that impact and mediate learning when conducting a school field trip with a telepresence robot.

Based on my findings in this study, implications for museum practice may include designing navigation tasks with a telepresence robot and re-thinking the role of the museum guide. As discussed above, I consider the collaborative navigation of the robot to serve as a foundation for discussions, reflections and engaging activities within a group. Visiting the museum with a telepresence robot require both the visitor and the museum to think in novel ways about what such visit should include. Considering the limitations in the robot when it comes to traditional information gathering such as reading signs, touching artefacts or watching informational videos, museums need to facilitate new learning experiences that distribute information in new ways. Collaborative navigation tasks may involve interaction with other visitors, it may include using the robot's camera to e.g. take screenshots and then use pictures

of the artefacts as part of project work in school, and it may serve as a social group-activity fostering affective skills such as collaboration and communication. The museum guide as a dialogical partner also becomes an important factor. Traditionally, the guide is the one leading a group on a visit in the museum. With the use of the robot, the guide is not in charge as the information-giver, but as an equal dialogical partner, that actively participates in the students meaning making process (Dysthe, Bernhardt & Esbjørn, 2012), without controlling it.

This study aims to contribute to the field of museum learning with novel technology, and seek to investigate how a telepresence robot can be used for connecting formal and informal learning institutions. Further research on this field may include involving the same class in a bigger project, conducting several field trips to different museums for exploring and seek out new information, to go global and visit museums outside of their own country, and to include more classrooms in the study. Using the indicators found in this study to create meaningful and novel learning experiences for museums and classrooms worldwide, to foster skills such as engagement, curiosity, collaboration and understanding and meaning making that are all crucial for humans to evolve and learn in the 21st century.

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Appendix

Appendix 1: Transcripts of audio recordings

Appendix 2: Worksheet questions

Appendix 3: Questionnaire given to the students post-visit

Appendix 4: Blank map of the Origins exhibition room

Appendix 5: Plan for debriefing session

Appendix 6: Interview with museum guide post-visit

Appendix 1

Group 1

Members of group 1	Other people present
Oscar Pierre Martin Teresa Aurelie Florence	In the classroom: Hanna-Marie, researcher Sofia, assistant teacher Jean-Pierre, teacher, walking in and out to observe In the museum: Cécile, researcher Maya, museum guide

00.30- 02.15
Sofia: Let's start ((background noise from Cécile & Maya talking with each other))
Aurelia: can you read? what is it?
Sofia: Find the three women standing next to each other
Martin: and ask the guide who are they
Sofia: you have to control the robot
Oscar: how?
Hanna-Marie: you control with these ((showing arrow keys on keyboard))
Oscar: oh, that's convenient
Hanna-Marie: this is to turn, and this is to move forward
Oscar: ah, my robot is rolling ((laughter from the rest of the group))
Sofia: you can try now
Martin: who is talking? Oscar! We have to ask the guide
Cécile: are you ready? Do you have the question?
Martin: Yeees! (laughter in the background) we are looking for the three statues ((several speaking at the same time)): the three statues of the women
Martin: the naked women((loud laughter from the rest of the group))
Sofia: no, not naked
Pierre: what? are they not naked?
Sofia: no, it is not the naked women
Marting: ((loud)) find the three statues of the women who are standing next to each other
Sofia: ok, let's go. You are piloting
Cécile: ok, try to move. You know what you are looking for!
Martin: try to go this way
Maya: it is closed that way
Cécile: look around you

Pierre: we have already arrived?
Martin: we have to find it ((discussion from two of the girls in the background, I cannot get what they are saying))
Aurelie: ah!
rest of the group: oh!
Pierre: that is it!
Martin: cool

Aurelie: what was the question?
Martin ((shouting)): who are they?
Sofia: ask the lady (the guide)
Oscar: who are they, the three statues?
Maya: the three statues are (.) do you hear me well?
the whole group: yes! they are three pre-historic women
Martin: ((whispering)) three pre-historic women ((noting down the answer))
Maya: the one to the right is the neanderthal-woman. The one in the middle is homo-sapiens, and the last one, the smallest one is the flores-woman
Teresa: floress-woman, the small one
Aurelie: okay
Cécile: remember to note down the answers
Martin: yes, it was homo sapiens. How do I write it?
Sofia: start with an h for homme
Martin: ok, got it
Cécile: can you all see them, is the camera okay?
the group: yes!
Oscar: next question! How are they different from each other?
Florence: what is the difference?
Martin: yes, between the three
Cécile: what are the differences that you observe?
Aurelia: that they are not very much alike
Florence: especially one
Maya: what is different about her?
Florence: she is very small
Maya: yes, she is the smallest one
Cécile: and this is interesting. Which one is the smallest one?
Martin: I know!
Maya: and why do you think she is the smallest one?
Martin: it is because she lived in another epoque
Maya: it is because she lived on an island
the whole group: ooh
Maya: we call this a species ensumer ((..I don't understand the word))
Aurelia: remember to write it down
Martin: I am writing
Aurelia: no, but not here ((pointing at the work sheet))
Martin: what is their differences ((reading the question again from the worksheet)) yes, it is here (5)
Cécile: did you have more questions about the women?
Teresa: yes
Martin: when did they live?
Teresa: when did they live!
Aurelie: ah, I will write
Maya: when did they live, okay. So, the neanderthal appeared 200 000 years ago
Aurelia: neanderthal 200 000 years. But it is really (.)
Martin: no, here, 200 000 years ago ((pointing to the worksheet))
Maya: and the flores-woman ((noise from other people in the museum))
Oscar: can you repeat that, please?
Cécile: okay, do you wanna go to the next question?
Oscar: no, repeat please

Pierre: we did not hear all the dates
Maya: ah, ok, should I repeat?
the group: yes, please!
Maya: neanderthal appreaed 200 000 years ago.
Martin: neanderthal, 200 000 years
Aurelie: I am writing it down
Maya: and the next one is 40 000 years ago
Martin: ((repeating)) 40 000 years ago
Pierre: And the last one?
Maya: the last one appeared 95 000 years ago
The whole group: thank you!
Oscar: but the first one, is she to the right?
Aurelie: yes, it is from the right to the left
Sofia: should we switch who controls the robot? ((they switch))
Hanna-Marie: the next task is to look at the map in front of you, and try to find and mark objects in the museum on the map
Teresa: we have 13 minutes left
Oscar: we have to finish writing about the women

Up until here I have transcribed all discussion. I find this taking a meaningless amount of time, and will after this note sequences with exact time, and transcribe e.g the five minutes around it.

They have finished the task and are now moving around in the museum

08.20-09.27
Pierre: you have to back up ((The whole group laughing))
Martin: ah, its a bit dark. its hard to see
Aurelie: its not so fast either
Teresa: go to the right here
Florence: this is so cool
Pierre: look over there, there is something, there is something!
Oscar: there is a diplodocus
Pierre: I can see it
Maya: can you move a bit forward?
The group: move forward!
Martin: but it is so dark
Pierre: where are we now? where are we?we have the statues here ((discussing around the map))
Aurelie: and then we moved here. I think we are here ((pointing to the map of the exhibition room))

09.42-11.11
Sofia: maybe you can ask the guide what you are looking at right now
Florence: what am I seeing here?
Maya: what do you think that you are looking at?
Pierre: it is a diplodocus
Oscar: I think it is a skeleton
Aurelie: it is a skeleton

Pierre: it is a skeleton of a diplodocus
Maya: it is a skeleton yes. if you back up a little, and you move the camera upwards you can see better, because it is very tall
Hanna-Marie: you move the camera like this. Now it is on maximum
Aurelia: maybe if you back up a little more
Martin: ohlala
Pierre: I don't think it is a diplodocus
Florence: is it a T-Rex?
Pierre: no, no
Martin: no, no
Maya: why do you think it is a T-Rex?
Florence: because of the head?
Teresa: and he has a mark
Maya: no, it is not a T-Rex
Pierre: But I think it is a diplodocus
Maya: ah, this one next to it?
Martin: it is a herbivore
Maya: this big one is called a camarosaurus
Pierre: oh, I don't know that one
Oscar: we have to note it on the map
Aurelia: how do you spell it?
P: camara, camara, camara ((Rest of the group laughs))
Sofia: spelling: ca-ma-ro-sa-ru-s
Oscar: Ok, its all good

11.49-12.30
Martin: oh la la, I know this one
Aurelie: but where are we now?
Pierre: yes, where are we?
Teresa: I think we are here ((pointing to the map of the exhibition))
Florence: this looks nice
Oscar: this is cool, really nice
Pierre: is this another dinosaur?
Maya: yes, it is a dinosaur
Pierre: this is a tyrannosaur
Maya: it is a carbosaur
Pierre: carbosaur?
Florence: carbosaur
Maya: we don't have a tyrannosaur here, unfortunately

13.04-14.49
Aurelia: what is this over here?
Pierre: but turn around
Martin: what is it?
Teresa: I haven't seen it
Pierre: but turn around ((laughter from the group)) go!
((The whole group shouting)): go, go!
Aurelia: watch out for the lady! ((group laughs))

Pierre: no, crash into her!
Maya: what are you looking for now?
Teresa: a dinosaur
Aurelia: we have seven minutes left
Oscar: [but] what is the one behind you?
Maya: this one?
Pierre: that is the diplo, no the camaro, camaro, camarasaurus ((group laughs, it is hard to pronounce))
Maya: yes, you have already seen this one
Aurelia: okay, turn ((group laughs))
Teresa: to the right
Pierre ((in an eager voice)): [to the right]
Oscar: there is another skeleton, or something brown
Florence: maybe it is a T-Rex
Aurelia: I cannot see it
Martin: [next to it, next to it!]
Teresa: I think it is a T-Rex
Florence: should I back up?
((The whole group shouting)): noo!
Florence: okay, how do I raise the head? ((point the camera upwards))
Oscar: use this one, and then you do this (.) ((demonstrates how to control the robot))
Pierre: now we can put down two crosses ((talking about the map of the exhibition))
Maya: ok, can you see it now?
Florence: yes, but what is it?
Maya: this is called a mosasaur ((mosasaurus in English))
Pierre: a mosasaur? ((group laughs)) (.) ((spelling)): mo-sa-saur ((group laughs))
Oscar: but this is not a dinosaur, it is a reptile! It is not the same (.)
Maya: yes, it is a reptile, not a dinosaur

17.16-19.46
Aurelia: but what is this?
Pierre: the thing that looks like a tree
Florence: or more like the roots
Maya: which one do you mean? There are so many
Florence: that one
Maya: this is called a pigosisalle
Oscar: okay, but mark it on the map
Pierre: where are we? ((pointing to the map))
Teresa: we are there, we are here ((showing on the map))
Aurelia: right next to the cross here ((talking about the map))
P: we are here. Because the camarosaurus is here ((showing on map))
Maya: so this one, is 287 million years old
Aurelie: wow
Pierre: okay, so next to the cross here ((on the map))
Oscar: yes, I am writing!
Pierre: but it is a fossile? A fossile of what?
Maya: yes, it is a fossile, a fossile marron
Martin: and what is it called?
Maya: a pe-go-se-fal
Pierre: pe-go-se-fal

whole group repeating: pe-go-se-fal!
Oscar: I don't know how to write that
Teresa: ste-go-se-fal
Pierre: you write it like st-e-g-o-s-e-fa-l

Group 2

Members of group 2	Other people present
Malia Lisa Ina Emma Rachel	In the classroom: Researcher Hanna-Marie Assistant teacher Sofia In the museum: Cécile, researcher Maya, museum guide

00.30- 02.20
((the beginning of the session, Emma is controlling the robot, Ina has the work sheet))
Cécile: have you read the instructions?
Emma: no((rest of the girls in the background:)) cool, this is awesome
Hanna-Marie: read all the instructions so you know what to do
Ina: okay, I read (2) find the big dinosaur. I know where it is! ((to Emma)): move forward, I know where the dinosaur is
Emma: how do I move forward?
Ina: just go to the dinosaur!
Lisa: but what is the question?
Hanna-Marie: you need to read all the instructions before you start moving
Ina: but I know where the dinosaur is! okay, what is the name, when did it leave, what did it eat. That is the question!
Emma: okay, I move
Rachel: did you see this over there?
Ina: move over there, and around
Cécile: okay, try to watch where you are going, there are other people here. Do you see there is a man next to you now? ((girls laughing))
Man in museum: oh, but isn't it ladies first? ((girls laughing louder))
Cécile: ((laughing)) I guess that is how it works
Emma: oh, but we are really in the "salle"? ((the room of the exhibition))
Hanna-Marie: yes, you are is really in the museum
Malia: ((says something that is hard to understand))
((hearing lots of people talking in the museum, girls are laughing))
Cécile: you can say hello to the people if you want to
Group: ((shouting)) Helloo, hello, hello! ((laughs))
Cécile: now you need to back up a little. back up
Emma: okay
Ina: but can we talk to the people over there? like, really talk to them?
Sofia: yes, yes you can talk to them

02.24-03.17
Lisa: back up and turn right
Ina: we are looking for the big dinosaur
Malia: ((louder)) we are looking for the big dinosaur! ((here they are shouting directly at the big screen that is projecting what they are seeing from the robot))
Sofia: the microphone is over there ((girls laugh))
Ina: we are looking for the big dinosaur. isn't it over there?
Malia: hello!
Maya: hello! so, can you raise the head
Sofia: and who is writing?
Lisa: I will write
Ina: oh look, it is all alone
Lisa: okay, what is the name?
Malia: it is a tyrannosaur
Lisa: is it a tyrannosaur?
Emma: I don't think that is what she said
Ina: wait, ask her, what is the name
((several girls at once)): what is his name?

06.20- 07.35
((the group have now moved on to the bonus-question, Ina is controlling the robot))

Hanna-Marie: so, the big dinosaur is marked here ((showing on the map))
Rachel: okay, and we, we do (silence) we are here
Malia: move forward ((silent in the group, background noise from the museum: a guide doing a group tour)) but look at all these people
Ina: helloo!
whole group: hello, hello! ((group laughs))
Malia: okay, keep moving forward
Emma: watch out for the kids over there ((group laughs))
Malia: turn, and move forward
Ina: where is it? can they hear me? hello!
Man in the museum: is it a robot?
Ina: hello!
rest of the group ((shouting)): hello!
Ina: yes, we are a robot ((group laughs)) what is it called? a robot what?
Woman in museum: hello!
Whole group: hello!
Cécile ((to man in the museum)): they are in the classroom, and are visiting the museum from there
Man in museum: oh, that is really interesting
Malia: okay, let's go now, move forward

09.39-11.38
((Malia is controlling))
Maya: hello
Malia: hello!
Rachel: ((to the group)) but how do we do now?
Ina: maybe we can ask some more questions

Malia: oh, sorry ((there are some people she wants to pass in the museum))
Malia: uhm, excuse me
Ina: ((shouting)) excuse us! ((group laughing))
Cécile: ((laughing)) okay, do you know what you are looking for now?
Malia: uhm, no. I am just looking, but
Rachel: let's find something
Emma: can we only be in this "salle" ((room))?
Hanna-Marie: yes, you can move around only in this room
Malia: okay, what are we interested in?
Rachel: what is that over there?
Malia: I have seen that
Ina: that is the big dinosaur
((silence in the group, background noise from the museum))
Rachel: what if we go there, to the left?
Malia: okay, I wanna se that thing over there
Malia ((to Maya)): what is that we are looking at?
Maya: this is an aboriginal painting
Malia: but what is an aboraganil painting?
((group laughs))
Maya: it is a painting made of the aboriginal people, who lives in Australia
Malia: ah, do they still exist?
Maya: yes, they still exist
Malia: okay
Ina: but you have to turn!
Malia: no, but let's see.. I want to see this ((to Maya)): what is this thing?
Emilie: this is still an aboriginal painting
Malia: oh
Maya: do you see this big snake over here?
Group: uhm, yes
Maya: this one is called the Rainbow snake. It represents the beginning of life
Malia: ah
Maya: for the aborigins
Rachel ((to the group)): it is really cool to see this or what
Emma: I really like it. I would like to go back to the Musée des Confluences to see this one
Rachel: I haven't seen the snake
Emma: but you can go back and see it for real
Rachel: no, but I have seen it now, I will tell teacher that

15.23-17.30
((Ina is controlling))
Ina: hello!
Maya: hello
Cécile: hello! what is your name?
Ina: Ina
Cécile: hello Ina ((group laughing silently))
Ina: ooh
Maya: ((in a very excited voice)): what did you find?
Malia: your friend? ((group laughs))
Emmma ((whispering)): it is a mammoth
Malia: that is a mammoth

Rachel: it is a skeleton of a mammoth
Emma: but it is super-big a mammoth like this
Ina: how big is it?
Rachel: the mammoth, what size is it? ((silence))
Ina ((shouting)): excuse me, how big is the mammoth, please?
Maya: actually here I don't know the exact size of the mammoth
Ina: okay
Rachel: but how old is it?
Maya: it was found in 1859
Emma: and where was it found?
Maya: wait. between 300 000 ((background noises, cannot hear what they are saying in the museum))
Ina: where was it found?
Maya: it was found really close to here, just two kilometres from the museum, in Lyon
Hanna-Marie: it is a Lyonnese mammoth ((group laughs))
Emma: it is a Lyonnese mammoth
Ina: ah, it is a Lyonnese mammoth!
Malia: a Lyonnese mammoth. What does it matter?
Emma: it was in Lyon, it was really in Lyon, but it does not exist anymore

Group 3

Members of group 3	Other people present
Francois Jean-Luc Alex Anna Amelia	In the classroom: Hanna-Marie, researcher Lena, assistant teacher Jean Pierre, teacher, walking in and out to observe In the museum: Cécile, researcher Emilie, museum guide

01.20-02.26
((Francois just finished reading the task, Jean-Luc is piloting the robot))

Alex: okay, so we have to find a visitor
Anna:no, we have to find a mammoth!
Amelia ((to Emilie)): we are looking for a mammoth
Emilie: ah, okay, but then you need to find someone who can help you, right?
Anna: cool
Francois: oh, cool
Alex: but is it a robot that is moving forward?
Jean-Luc: look, there is a lady, watch out
Amelia: no, shout at her!
((group laughing))
Alex: we are really inside a robot!

Anna: ladyy
Rest of the group((shouting)): lady, hello
((group laughing))
Alex: but you have to say hello lady
((noises from the museum in the background))
Francois: but seriously
Francois: let's ask this man over there!
Alex: uhm, hello lady, can you speak?
((group laughing))
Cécile: okay, this man is ready to talk to you
Jean-Luc: do you know where the mammoth is?
Man in the museum: uhm, the mammoth, no I don't know
((group laughing))
Cécile: okay, then you need to find someone else
Jean-Luc: thank you!

02.30-03.05
Jean-Luc ((to someone in the museum)): can I pass here, please?
((group laughing loudly))
Emilie: okay, just pass over there
((group laughing loudly, someone claps their hands))
Alex: turn, turn, turn!
Jean-Luc: but, but
((group laughing))
Alex: no, turn! ((laughs))
Jean-Luc: but I can't ((laughs))
Emilie: okay, this is a wall ((laughing))
Emilie: you can't get any further, you have to back up

03.50-06.01
((Alex is piloting))

Francois((to Alex)): now you are in the robot
Alex: can it go any faster?
Hanna-Marie: no, not really
((group laughing))
Francois: it is not very fast, it should go faster
((Alex and Hanna-Marie laughs))
Francois: okay, so say hello to someone
Francois: you say hello, excuse me, can you help me find the mammoth
((rest of the group laughs loudly))
Alex: hello lady
Cécile ((to the girl in the museum)): do you speak French?
Girl in the museum: not really
((group laughs loudly))
Hanna-Marie: okay, she doesn't speak French
Alex: let's find someone else then
Alex: how do I do to turn around?
((Francois is laughing))
Lady in the museum1: hello!

Jean-Luc: oh, sshh
Alex: hello!
Alex: uhm, do you know where the mammoth is?
Lady in the museum 1: uh, the mammoth? no, I don't know
((group laughs))
Alex: okay, thank you anyway
Lady in the museum 1 ((laughs)): of course, you are very polite!
Francois: ask the man over there, ask the man!
Alex: but haven't we talked to him already?
Anna: no, turn, turn
Jean-Luc: what happens when we find the mammoth?
Francois: but turn around, there is a lot of people over there!
Alex: uaah
((group laughing))
Francois: but you have to turn before ((laughs))
((group laughing loudly))
Anna: now there is a lady
Alex: hello, excuse me, do you know where the mammoth is?
Lady in the museum 2: oh, the mammoth, it is just to the right, in the room next to this one
Cécile: did you understand?
Alex: yes, thank you!
Lady in the museum 2: you are welcome!
Alex: see you!
((group laughing))
Alex: ((in a singing voice)): and I am rolling!
((group laughs))

06.48-07.55
((they are passing through the exhibition to get to the room with the mammoth))
Amelia: I see a fossil
Alex: I have seen this before
Cécile: what is it that you have seen?
Francois ((to Alex)): say the big skeleton
((silence, background noise from the museum))
Francois ((to Alex)): you were good at asking the lady ((making a pretend-voice)) uh, mammoth, please
((group laughing))
Jean-Luc ((shouting)): the mammoth!
Amelia: ((shouting)) oh, the mammoth!
Alex ((in a singing voice)): we have found!
Francois ((in a dark voice)): we have found the mammoth!
Amelia: it is cool
Anna: it is so cool
Jean-Luc ((reading from worksheet)): so, where was it found?
Amelia: maybe we have to look at the sign
Anna: look at the sign
Francois ((shouting)): the sign!
Alex: there is no sign
((Alex is leaving the piloting post, Anna is piloting))

08.34-09.27
Cécile: so, can you see the mammoth
Anna: yes, it is right there
Cécile: but can you see all of it?
Group: no
Cécile: okay, so back up a little and tilt the camera at maximum height
Anna: it's good!
Alex: ah, it is good like this
Cécile: can you see it better?
Anna: yes
Amelia: the question is, where was the mammoth found?
Emilie: it was found on the hills of Choulans, in Lyon, two kilometers from the museum
Jean-Luc ((to the rest of the group, writing)): at the hills of Choulans
Anna: okay, thank you!

11.46-12.44
((Francois is piloting))
Anna: the question is, what do you know about mammoths? write down two facts
Alex ((to Emilie)): what do you know about mammoths?
((Emilie laughs))
Cécile ((laughs)): no, this is for you, the group, what do you know about mammoths?
Group: aah
Cécile: you can move around the mammoth, to see if it helps you come up with something, maybe you can find something interesting
Alex ((to the group)): so, what do you guys know about mammoths?
Amelia: can you hear me?
Francois: something is not working
Amelia: but a mammoth, I have seen is super-fun
Anna: was it like this, like big?
((Amelia and Anna laughing))
Amelia: yes, I have seen it! It is pretty

12.47-14.44
Francois: it is not so fast!
Amelia: we are here
Alex: ask these people
Francois: hello
((noise from museum in the background))
Amelia: we need to turn
Alex: go!
Jean-Luc: watch out!
Francois: there was a lady, ups
((group laughing))
Man in museum: oh, what is this?
Jean-Luc: it was not a lady, it was a man
((group laughing))
Alex ((in a pretend-voice)): the mammota
Francois: but yes, let's ask him about the mammoth!
Francois: listen, what do you know about mammoths?

((noise in the background in the museum))
Alex: but the mammoths they are what, really?
Jean-Luc: the mammoths are pre-historic
Alex: then they are already dead
Jean-Luc: we cannot see mammoths now anymore
Alex: and they have fangs
Jean-Luc: fangs
Alex: okay, move forward then, ((in a pretend-voice)) accelerate!
Francois: it is still not so fast
Alex: it's okay, it's moving forward well now
Francois: can I not make it go any faster?
Hanna-Marie: sorry, you have it on maximum speed now
Jean-Luc: okay, so they have fangs, and they have really long fur

15.54-16.35
((a whole class of teenagers on a field-trip to the museum has gathered around the robot))

((group is laughing))
Francois: hi, hello ((laughs))
((group laughs loudly, laughter and noise from the museum))
Teenage boy: uh, what is your name?
Francois: my name is Francois
((group giggles))
Teenage boy: what, Frank?
((group laughs loudly))
Francois: no, Francois!
((noise from the museum, all group of teenagers are talking and buzzing))
Francois: okay, goodbye, see you!
((group giggles))

Group 4

Members of group 4	Other people present
Tomas Leyla Gina Gerry Ron Daniel	In the classroom: Hanna-Marie, researcher Lena, assistant teacher Jean-Pierre, teacher, walking in and out to observe In the museum: Cécile, researcher Maya, museum guide

((In this group Gina and Gerry did not want to try to control the robot))
((This group in general was quite shy, and had a hard time in the beginning, not talking much, and not moving around much, needed encouragement from guide and researchers))

00.28-02.36

((Daniel is controlling))
Daniel: is that a meteorite?
Cécile: this one?
Daniel: yes, is it a meteorite?
Ron: but is it real or is it fake?
Daniel: I think it is a reproduction
Maya: and why do you think it is a reproduction?
Daniel: I don't think there really is one in the museum
Maya: it is a real one, and you can even touch it ((Emilie is touching the meteorite))
Leyla: ooh
Daniel: really?
Maya: yes, it is a real meteorite, and it fell down in year 1967, in Algeria
Daniel: okay
((silence for about 10 seconds))
Cécile: did you have any questions regarding the meteorite?
Ron: uhm, yes, what is the name of the meteorite?
Maya: it's called Marcel ((laughing))
Leyla ((almost whispering, to the rest of the group)): what is the name of the meteorite?
Maya: no, it is called Zerhamra ((spelling)) Ze-rham-ra. That was the right answer ((laughs shortly))
Leyla ((almost whispering)): how did this meteorite arrive on earth? ((silence for 5 seconds))
Daniel: how did this meteorite actually arrive on earth?
Maya: ah, okay, interesting question! so, a meteorite is first part of something larger called an asteroid, okay?
((group mumbling)): okay
Maya: and these asteroids circulate between Mars and Jupiter. But sometimes they crash, and then pieces of an asteroid can loosen and be tossed into space, and after millions of year one can go through the atmosphere of the earth.
Ron: so one hits the other
Daniel ((whispering)): I haven't seen it
Maya: Exactly, and the piece that finally lands on the ground is called a meteorite
Daniel ((almost whispering)): uhmm ((inaudible sound))
Maya: what did you say?
Daniel ((whispering to the rest of the group)): but where was it found?
Leyla: Algeria
Ron: it was Algeria, wasn't it
Maya: in Algeria, yes
Daniel: ah, that's true
Maya: in the desert in Algeria
Ron: in the desert!
Leyla ((whispering to the group)): do you think it hurt anyone?
Maya: sorry, I didn't understand
Ron: did it hurt any people?
Maya: I don't know, but I don't think so, it was found in the middle of the desert

04.22-05.03

((The group has discussed shortly the question about the moon, but goes back to the meteorite))

Daniel: so it creates like a big, big hole
Maya: excuse me?
Daniel: it creates a very big hole
Maya: ah, the meteorite?
Daniel: yes
Maya: yes, it creates a big hole, a crater, when it hits the earth
Daniel: yes
Maya: but it looks kind of pretty, the crater
Daniel: okay. but it goes really really fast, doesn't it?
Maya: absolutely, it goes really fast, and when it enters the atmosphere it is really warm, and pieces of it burns up before it hits the earth

05.16-06.10

Tomas ((speaking quietly)): but hey Ron, that is not very nice
Tomas: it is not so nice to roll on the guide
((group laughs))
Cécile ((laughs)): no, it is maybe not so nice to roll on people
Ron: okay, if I move the robot over here, it will not roll over the guide, huh?
((group laughs))
Cécile: no, that was better, thank you
((silence for about 10 seconds))
Cécile: so, what are you looking for now?
Daniel: I would maybe like to see a dinosaur
Cécile: a dinosaur, okay, then go search for it
Leyla: turn around
Cécile: okay this is a dead end, you need to turn around, turn around, good, and then go
((group giggles))
Cécile: you are a really good driver

07.07-08.36
((Leyla is controlling))
Cécile: okay, what do you see?
Ron ((shouting)): a dinosaur skeleton!
Leyla: a dinosaur skeleton
Cécile: okay, if you move a little backwards and try to tilt the camera, so that you can see the whole dinosaur. It is quite big
Cécile: and when you see it well, you can ask questions and we can discuss the dinosaur
Leyla: what kind of dinosaur is it?
Maya: it is a camarasaurus
Ron: aah, a camarasaurus?
Daniel ((shouting)): camarasaurus! they are gigantic the camarasaurus!
Ron: a really big dinosaur
Maya: it is a cousin of the diplodocus

Daniel ((in excited voice)): aah, the diplodocus, cool! they are gigantic also
Leyla: how do you spell it?
Maya: ca-ma-ra-sau-rus
((Daniel and Ron repeating)): ca-ma-ra-sau-rus!
Leyla: oh, but it is already marked on the map here
((silence and background noise from the museum for 5 seconds))
Leyla: when did it die?
Maya: When did it die. Hm, we don't know the exact date when it died, but we know it lived about 155 million years ago
Leyla: okay
Daniel: let's move on
Cécile: yes, there is a group doing a tour here now, it is a bit hard to hear you
Daniel ((to someone in the museum)): hello (coucou)
Maya: watch out for the people
Ron: you can pass through there
Leyla ((to Daniel)): is it herbivorous or carnivorous?
Daniel ((to Leyla)): it is herbivorous, like the diplodocus

11.38-12.43

((Ron is driving, they have been watching the camarasaurus for around 5 minutes))

Maya: hello
Ron: hello! can we look at some other things as well?
Maya: excuse me, I did not hear
Ron: can we look at some other things also?
Maya: of course, you are the one controlling! What would you like to see?
Daniel: maybe another dinosaur?
Ron: let's find something interesting
Leyla: look, look! There is some kind of goat
Daniel: cool
Ron: go, go! ((short laughter from the group))
Daniel: don't break anything! there is a small kid ((Leyla giggling))
Cécile ((in English, to the visitor in the museum)): yes, it is a real person in the robot, a boy called Ron
Ron: but I'm not really a robot. hello!
Man in the museum ((to his kid, in English)): look, there is a boy in the robot, you can say hello!
Kid ((around 3 years old, in English)): hello robot
((group laughs))
Daniel: careful so you don't crush the kid
Man in the museum ((to his kid)): maybe you need to say "bonjour"
Kid: robot, hello
Daniel: he is a champion this one
((group laughs))

Appendix 2

Questionnaire pour une visite de la salle Origines du musée des Confluences au moyen d'un robot de téléprésence

Instructions

- Organisez votre équipe :
  - décidez qui contrôlera le robot, prendrez-vous des tours ?
  - qui parlera avec le/la guide ?
  - qui écrit sur la carte ?
  - qui contrôle le temps ?
  - qui rédige les réponses ?
- Lisez toutes les questions AVANT de commencer, certaines réponses se trouvent dans les informations disséminées dans le musée, d'autres font appel à vos connaissances acquises précédemment.
- Vous avez 20 minutes !

Questions

1. Allez voir le grand dinosaure. Comment s'appelle-t-il et quel âge a-t-il ? Que mangeait-il ?
   Objectif pédagogique : Repérage dans le temps. Histoire de la Terre, préhistoire, dinosaures.
2. Trouvez le mammouth. Où et quand a-t-il été découvert ? Ecrivez deux informations que vous connaissez à propos des mammouths.
   Objectif pédagogique : Faire la connexion entre l'objet devant soi et des connaissances déjà assimilées. Histoire de la Terre, évolution, géographie.
3. Trouvez les trois femmes debout les unes à côté des autres. Prenez une photo d'elles en utilisant la capture d'écran de votre ordinateur. Quand vivaient ces femmes ? Sont-elles toutes nos ancêtres ?
   Objectif pédagogique : évolution de l'espace humaine.
4. Trouvez le fragment de lune. Comment ce morceau de lune est-il arrivé sur la Terre ? Ecrivez deux informations que vous connaissez à propos de la lune.
   Objectif pédagogique : le système solaire, comment la lune affecte la Terre.

   Bonus:
   Vous avez une carte de la salle. Faites au moins 4 croix et inscrivez ou dessinez ce qui s'y trouve.
   Objectif pédagogique : représentation d'un espace, repérage de l'élève dans cet espace

Appendix 3

Avez-vous visité le Musée des Confluences?

Avez-vous visité d'autres musées? (A Lyon, ou ailleurs?)

Que pensez-vous des visites de musée? Allez-vous souvent dans les musées?

Avez-vous rencontré des difficultés lors de la visite avec votre groupe?

Comment votre groupe a-t-il collaboré?

Avez-vouseu des surprises lorsque votre groupe visitait avec le robot?

Ce qu'il a bien fonctionné et qui n'a pas fonctionné dans votre groupe?

Qu'avez-vous appris durant la visite?

Cette visite a-t-elle été différente de une visite d'un musée en personne? Précisez.

Appendix 4

Map of the exhibition room

Appendix 5

-Chaque groupe lit sa question, et sa réponse. Si 2 groupes ont répondu aux mêmes questions, ils confrontent leurs réponses et se complètent.

- On leur montre que c'est le travail de chaque groupe qui a permis de répondre au questionnaire.(une forme de travail collaboratif)

-On revient sur les façons de travailler dans chaque groupe: partage des rôles, aide, coopération, difficultés rencontrées pour obtenir les réponses, pour piloter le robot, pour s'entendre avec les membres de l'équipe, ...

- bilan à mettre en lien avec les connaissances issues des travaux réalisés en classe sur ces questions-là avant la visite à distance (cette année ou l'an dernier)

<u>La séance de visite du musée:</u>

- projection des photos et vidéos des travaux des groupes réalisées à l'école et au musée.

- remarques, observations, questions des élèves à propos de cette visite à distance par robot interposé (hors celles relatives au questionnaire de visite)

- demander à qui cette visite à distance a donné envie de visiter "pour de vrai" le musée.

Appendix 6

Interview with museum guide after the visit

What are your thoughts and comments on this experience?

I thought it was very interesting regarding accessibility issues, for people who don't have the opportunity to come to the museum because they're far away, or for security reasons, like we have these days [this experiment was made a month after the terror attacks in Paris and during State of emergency]. This could be a good solution if kids can't go on school trips or for people in hospitals or abroad, it can be super duper ! It's a nice project, even for us. There are things to work on, like problems regarding the sound but it could be a beautiful partnership, I think the kids really liked it. I think they're like all the kids we meet inside the museum : they're drawn to everything that's around them. Its a nice project and it worked well.

What would you say of the length of the visit and its objectives, like the treasure hunt ?

I think 20 minutes is too short : between discovering the robot and the room, I think we could use 45 minutes, we could then ask more questions, even if it means they don't answer them all, but it would enable them to get familiar with the tools, the space they're in. Even when we make an hour and a half visits in real life we have to bring the children back into focus very often.

What about the groups? Are 6 kids a good group?

It works well. Maybe we should give them stricter rules : like, only one gets to talk, because sometimes there are three children trying to talk in the back at the same time et we can't hear anything. But small groups are nice. There's a rotation, we get to see all the kids. Maybe there should be a pre-visit so that they already know the tools and the space. That would be good. But it's a bit complicated to organize. I think there is this question of apprehending the space and the robot. The target-objects didn't really work out, but your scenario was sound : the three women, the camarasaurus, the mammoth and the meteorite, that's what we usually focus on during our own school visits.