Designing Interactive Learning Environments For Children

The Implications Of Using Storytelling & Play forms Such As Treasure Hunts In Museums

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Abstract

There are many examples of museums trying to create a playful environment for children, using Ubiquitous computing, Virtual Games and Physical Computing. However, are these cultural spaces creating a learning environment, which fosters Play? The first part of my thesis concentrates on the theoretical groundings of Play, Storytelling and Learning and examples of how technology supports the creation of a tangible interactive environment. I then interpret these findings and look at how they can be incorporated in creating a fun learning experience, incorporating cultural artefacts.

The second half of the thesis shows empirical research in the area and the final design concept. The design process is formulated around a Participatory Design approach, and the final concept derived using a video scenario.

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1

Introduction

1.1 Children, Culture and Museums

Learning in museums has historically focused on a more structured, formal environment, whereby the teacher /guide accompanies the children and reads out the things that children should know about. The understanding becomes
limited as the communication is structured in a hierarchical way and children are not able to challenge and step into this adult world as they are just listening to a form of authority. The interaction is also limited as in most cases the children aren’t able to touch anything in the museum. However more recently there has been a shift to creating informal museum settings. This is definitely true for science museums and maybe less widely adapted to historical museums where artefacts and collections are housed. Moreover the shift to creating this informal learning environment is apparent when looking at both physical and digital interactions that exist in some of these cultural spaces. These environments help in creating an embodied experience for both children and adults, where they can embrace sensory elements, using one or more of their senses, to a more digital experience, which might involve gaming elements. (Cleaver, 1992)

Play is something that children at a pre school age seek out in any situation. Therefore the more this is embraced in museum settings, the better the learning experience for children is likely to be. Play comes in many forms, but the most important for preschool children is that related to object play and physical play. Children at preschool age want maximum fun and this is achieved through this physical aspect. However when applying play to a museum setting we are able to see collection play to be of importance in this case, in maintaining enthusiasm and creating the learning environment which they endeavour to achieve.

Another layer which is interesting to add to a museum setting and helping with creating a learning environment, is that of storytelling. Lets go back to basics with learning. What is it that children like to originally do? and what fosters growth in their original learning environments, be it the home or school? Play as we know is one. Another is that of stories. Parents read books to their children and books are also an integral part of learning in school. The way in which, children’s stories are normally set up help in creating curiosity and questioning; why does it work like this? what is this used for? Museum curators need to use this as leverage in designing spaces for children and helping the children to be in control and maintain a level of authorship, to in-turn achieve this learning. Robin Simons of the Children’s museum in Denver says “ By exposing children to the inside story, we not only answer questions about that specific item, but we pique their curiosity about other things as well, so that they begin to look more questioningly and wonderingly at everything around them”. Through exposing children to this and helping develop their curiosity they gain ownership of a concept through personal experience with it. (Cleaver, 1992)

As a part of my research with museums and children I collaborated with children at the International pre school and the Världskulturmuseet (worlds culture museum) in Gothenburg. The aim was to understand the way
in which children incorporate and understand `play´ in their world, and then use this as a leverage in helping create an environment which engages the children at the museum and develop a learning experience, through `storytelling´. It is also important to note that for the experience to construct meaning for the child, learning needs to be achieved through `ownership´ of the experience. The design process saw the children as the authors and the main participants.

1.2 Research Problem

I feel that science museums can differentiate themselves from more historical places for children, in that they have many forms of interactions that take place, with the main differentiating element being that of being able to touch the objects present. On the other hand some museums, which house historical artefacts, keep their objects in glass boxes following a “hands off” approach. As we know there is a shift in making the environment of cultural and historical museums more interactive and my research question focus on how this can be done, and how at the same time a playful learning experience developed.

1.3 Research Question

Children can be engaged in a museum setting through simple interactive artefacts combined with storytelling and play forms such as treasure hunts.

1.4 Personal Motivation

During this last year, my interest in designing for children has grown. I am interested in understanding the cognitive development of a child as theoretical practice as well as how it actually works in reality. Children at preschool age especially are only just gaining an understanding about the abstractions, which exist in their unfamiliar world. It is therefore interesting to challenge their schemata and gain an understanding of their motivations in making the decisions that they make.
Moreover the motivation to understand the learning process in a museum setting and making this learning process interactive, through a participatory approach, is based on the fact that children are the future. I have identified a gap in the approach to learning in cultural centres, such as museums (mainly those that house collections). I am interested in incorporating the ideas that are encouraged and innate to children at this age, into museum settings. I also feel that learning is not necessarily a taught process, instead children are engaged more so through experiencing and drawing their individual conclusions, through questioning. The interesting thing in terms of learning here is that there is a general sense of how children learn when looking at their cognitive abilities, but when applied to a situation for them to create meaning, the process can’t be generalised as such. Nevertheless the direction centres on the motivation that children need to be exposed to many different environments at the preschool age and I feel that their environment will contribute to shaping their interactions, socially, culturally and intellectually. For this reason I feel that the learning process is of importance, and it is through the way in which they learn and the content of what they learn that they are able to create meaning of the world around them.

1.5 Research Method

My research method is based on a Research Through Design approach. This approach looks at broadening the scope and focus of designers, and challenging current perceptions. This method therefore enables researchers to focus on the future, and become more active and intentional constructors of the world they desire (Zimmerman, Stolterman, Forlizzi, 2010) . This method is contextualised in my work through gaining an understanding based on analysis of the preschool and museum community. The knowledge gained was used to implement appropriate decisions and ultimately a well-grounded design outcome. The method of research inquiry is supported with Participatory Design methodology, which has been a primary source in helping establish my findings. The incentive of Participatory Design is to encourage the active involvement of potential or current end-users of a system in the design and decision-making processes. (http://www-cs-faculty.stanford.edu/) Furthermore this design process involved the children in the entire process, and contributed in making my decisions and shaping the
design for the museum setting. The children became participants in the way that they observed and interacted at the museum and offered their ideas on what they liked and didn’t like. Their ideas were conceptualised through their participation in building and sketching, making them users who didn’t just react to an already established design but took part in testing the prototypes and the final design concept.

Moreover, interaction design is a discipline described by Preece, ‘as designing interactive products to support people in their everyday and working lives’ (Preece & Rogers, 2002). In actively involving the users I was able to ensure that the final interaction design met their needs and above all was ‘usable’ for the school community in the museum setting. In this context Usability refers to not just the quality of the artefact itself but also a quality created during use (Cockton, 2004). This definition is applied to my design process in the way that the methodology extends beyond creating a functional design, which relates to the quality of the artefact itself, but the functionality of the specific design fosters a learning environment, creating the quality during use.

The research method includes a “cultural probe” exercise in their familiar setting, the preschool to further gain understanding of their perceptions. Probes are a new approach to gaining contextually-sensitive information in order to inform and inspire the design of new technology. (Gaver & Dunne, 1999) The cultural probe exercise was related to a role-play, whereby the children sketched answers to questions, based on the context of an Earthling’s exhibition that the children visited, prior to this. The idea of the role-play was that an individual was able to get into character, or to become something or someone else.

The research method also includes “focus groups” (circle time) through which we sketched and built, whilst discussing their perceptions in an open, comfortable environment. The key with using this method was to understand that not all children are comfortable with speaking out aloud in a big group and might not be so inclined to do so in front of someone that they haven’t known for long.

Observations of the children at the museum and at the preschool itself, without having to put them in the limelight enabled me to understand how they play together and individually, which contributed to the convergence of ideas as the design process developed.

The research methods detailed above ultimately resulted in creating a learning environment, through play and storytelling. The learning was based on them gaining a better understanding about the educational objects and collections that exist in the exhibition at the museum.
1.6 Structure of the report

2. Framing The Design Space
Outlining the main activities of preschool and the world culture museum, to gain a better understanding of the cultural institutions that I have worked with.

3. Museums & Learning
Establishing learning in museums and the context in which this happens. This chapter looks at how museums try and create a learning environment through engaging their visitors and shaping a space to help foster this learning, through engagement.

4. Learning Through Play
This chapter looks at the notion of play amongst children, in their everyday lives. What is play and what are the different types of play? How can we promote learning through the idea of play?

5. Cognitive Development
This chapter underlines a few theories of cognitive development. The first focuses on Piaget’s stages of Psychological development, where he looks at how a child’s knowledge and abilities change according to age. However Lev
Vyotsky goes beyond this and mentions how socio cultural factors also influence development. I also mention the ways in which children develop their symbolic representation and problem solving skills as part of cognitive development.

6. Learning Through Collections
This section brings in the understanding of the previous two chapters, of play and cognition to try and understand how object oriented activity can help learning, and how minds and hands are connected

7. Tangible Interaction Design For Museums
This section looks at creating an environment supporting tangible interaction. It looks at some related work examples and how these can be incorporated in making culture and history interactive.

8. Storytelling In A Collaborative Environment
This section talks about how storytelling is incorporated in a child’s environment and then extrapolates this notion and applies it to the physical and digital environment, with also a look at how storytelling has been used in museums as a part of collections.

9. Design Methodology
Looks at the Participative Design process and what this involves, with a look at how children worked as informants in my design process and through sketching and building and participating. It also looks at the contributions of the child’s role in the development of new technologies.

10. Design Process
This chapter details the initial design process, through exploratory workshops, which were based on visiting the museum, building and sketching. Here I am able to critically evaluate the participatory skills of the children and my skills as a researcher.

11. Turning Knowledge Into Action
Here I take the learning from the exploratory workshops and develop themes around which I conduct three workshops built around low fi prototypes.

12. The Final Design Concept
This section provides a detailed description of the final design concept that I implemented in the museum and also details the User Testing that was conducted in this space.
13. Reflections & Discussion
This is the summation of the research process, whereby I exemplify the main points that I have discussed throughout the paper and critically link these points back to my final design.

2

Framing The Design Space

2.1 The International Pre School

The International Pre School is a privately run preschool for children aged between 0 and 6, where I conducted workshops with a group aged between 4 and 6. The school has four branches in Gothenburg: Majorna, Guldheden, Biskopsgården and Älvsborg. My research has been based at the Biskopsgården pre-school. The International Pre School has one director and two managing directors who oversee all fours schools, and over 30 teachers, with more than one teacher running each class. The group that I worked with had one main teacher and one extra teacher who would help with all extra curricula activities.

Both the teachers and the children come from mixed backgrounds, and the main language at the schools is English. The kids communicate in English, even though this is not necessarily their first language. The school is driven by the following value;

“To acquaint children with diversity and increase their tolerance of dissimilar cultures. To equip them with a strong foundation of knowledge within a
multicultural microcosm and prepare them to become better world citizens."(http://www.theinternationalpreschool.com/)

The pre school has the belief that play is an essential stepping-stone to future learning as it develops social skills and imagination. Play is also seen to build strengths and interests as it motivates a child to want to learn as they bring a part of themselves to the materials that they interact with, and therefore, allow self-expression (www.theinternationalpreschool.com) As well as play being an integral part of a child’s experience, experiential learning is also encouraged, through workshops, cultural exchanges, museum tours and nature expeditions. The learning experience for each child is therefore born through “participation” and from “learning by doing”. The school believes in the importance of interaction, expression and feeling.

2.2 The Världskultur Museerna (The World Culture Museum)

2.2.1 Background

The Världskultur Museerna shows changing thematic exhibitions, incorporating the different parts of the world’s culture. Exhibitions range from photography to research and collections, related to specific themes. They currently devote a few exhibitions to children and schools and also invite families into the museum where they participate in creative art and design projects. The museum aims to promote an enjoyable learning experience for children and adults.

With experiential learning being key for this school and many other schools there is a shift towards a “hands-on” museum as opposed to a “hands-off” one (Cleaver,1992). The museum offers an environment to educate, create a communicative platform through constructing meaning of objects in relation to other objects, and offers an interpretive framework. (http://www.varldskulturmuseerna.se)

The museum is currently open to an exhibit called “earthlings” which focus’ on a role play environment for children. The children pretend to be aliens and are visiting earth to gain knowledge on how they live, the music they listen to, their sleeping patterns, nature and languages. This exhibition has undertaken the “hands on” approach to learning, through interactive buttons, sounds from movement and voice through headphones. However at the same time there is still a lot of room for development and space for creating a wider interactive experience.

2.2.2 Moving Forward
The museum will see a shift in paradigm, and move a few thousand objects into the museum, next year. These objects will comprise a classical ethnographic collection. The curators feel that there is a need to make collections relevant for young children. The framework needs to be developed around the following questions;

1. How should we use the objects?
2. What do they mean?
3. What did these objects mean in their natural environment from the beginning?

Overall, both the museum and the pre-school, work towards providing a learning environment for children and the theme of play is central to this learning. The pre-school is able to bring the more formal environment into the museum setting and let the children explore through structured school programs. However at the same time children can also enter a more informal environment, where they are able to train their curiosity with the ability to reason, think and question.
3

Museums and Learning

3.1 Learning In Museums

Museums can have a huge impact on children’s motivation and interest in learning. Dewey writes that this creates “the kind of present experience that lives fruitfully and creatively in subsequent experiences”. (Dewey, 1963) When discussing the intrinsic motivation in museums, Csikzentmihalyi & Hermanson (1995) look at how “one often meets successful adults, professional, or scientists who recall that their life long vocational interest was first sparked (as a child) by a museum.”

Museums are therefore seen as playing a direct role in helping children gain an understanding of material culture and the important history that this culture represents. Museums are used for preserving and displaying records of social, scientific and artistic accomplishments; “where society supports scholarship that extends knowledge from paleontology to meteorites; and where people of all ages turn to build understandings of culture, history and science.” (Leinhardt, Crowley & Knutson, 2002). For this reason it is important for museums to be attractive and inviting places, which children want to visit and spend some time in. However museums are seen to increasingly compete with other cultural institutions offering educational activities. Additionally museums can be perceived as being boring places, where one moves from one place to another, passively viewing objects and/or passively listening to historical accounts from the past.

This problem seems to be heightened through the prevalence of guided tours and encasing objects behind glass boxes. (Hall & Bannon, 2005)
The best learning in museums comes when people are engaged cognitively, physically and emotionally (Csikzentmihalyi & Hermanson 1995). To make any visit an enjoyable and involved experience, it needs to foster curiosity, creativity and fun (Falk & Dierking; 2000) Children should be able to explore the concepts with physically interactive experiences, adaptive and reactive information, as well as being able to play roles of explorers, scientists and artists, on top of manipulating image sounds and objects. (Druin, 2001)

Various forms of interactive technologies have been installed in exhibition spaces, as a way of engaging the audience and introducing a new way of learning. These experiences vary from interactive technologies, exploring augmented reality, contextual exhibition guides and a variety of mixed reality and tangible interaction, combining physical and digital material in the exhibition space. (Dindler, Iversen, Smith, Veerasawmy, 2010)

The process of learning becomes enhanced and extended through digital augmentation, to be able to support exploration and reflection when away from the classroom. (Rogers et al, 2004).

Mobile devices are examples of providing learners with the ability to learn anytime and anywhere. Mobile devices can also support social interaction, which is important when sharing information, ideas, constructing understanding and shaping knowledge. (Cole & Stanton, 2003). Moreover from combining the capabilities of computer technology with that of physical interaction, tangible user interfaces have been seen as an attractive option to traditional screen based computer interaction. (Hornecker & Stifter, 2006).

Moreover it is important to note that museums aren’t just concerned with employing new technologies to help increase the experience for children. They need to think about framing the relationship between the museum and its audience. This is criticised in a way, which looks at understanding the nature and dynamics of the museum experience, as something, which is more than just a transfer of knowledge of a value free authority to a uniformed receiver (Hooper-Greenhill, 2001). The museum experience is shaped by a wider context of social, personal, and institutional factors in which visitors interact (Falk & Dierking, 1992). The interaction design and children community, researchers have explored the issue of exhibition spaces, leading to the emphasis on emerging technologies, to help support children’s learning, active engagement and social behaviour in the exhibition spaces. For museums to therefore provide a successful informal learning experience, we need to look at how active engagement is achieved through the use of both digital and tangible technologies.
3.2 Engagement

If we are going to look at maintaining an interesting experience for children in museums we need to look into the notion of engagement. Engagement responds to a particular attention to how the audience invest their time, skills and knowledge in exhibition spaces. We understand that it is an obvious notion whereby some technologies and exhibitions work more positively in maintaining this engagement when compared to others. Creating engaging interactive environments therefore involves a complex mix of artefacts, physical surroundings and social relations. The key here is integration. Exhibits are no longer seen as separate entities put on display in any space. They are however seen as important elements of a total environment, with the audience, who are involved in creating a dynamic relationship with their space and the elements that exist in this space. The audience therefore move from being a passive spectator, standing and observing an exhibit to an active participant. (Parry, 2010) Moreover engagement is dependant on what people bring to the situation. People invest their time and efforts in particular situations based on prior knowledge and experiences.

It is important to define knowledge at this point as this differs for both adults and children. Knowledge is what we acquire from interacting with the world; it is the result of experiences organized and stored in each person’s, which is unique to that individual. It is formed from two main kinds; knowledge about things and know - how. Individuals make their own by being able to transform the experience from the outside into internal knowledge. (Parry, 2010) This understanding is taken a step further in the way in which we can see that an adults experience in a museum is more reflective and contemplative, pulling from their personal inventory of life experiences, knowledge and personal meaning. However, in contrast to this children are still trying to unravel the complexities of life and understand themselves through experiences that allow them to explore, participate and play a part. Even though their consumption of history and culture might be very different, they are also drawing on experiences, trying to understand themselves and acquiring personal meaning. At the same time children’s reactions and interactions to the world around them are quite different in the way that they are full of movement, noise, emotion and energy. Behaviours that adults do
not consider or even imagine, let alone accommodating or encouraged in the creation of our exhibitions. (McRainey & Russick, 2010) As we know this idea is critically challenged in museums today, and there has been a move away from the more traditional museums, which elicit knowledge and experience into a closed, highly controlled environment and give meaning to things in a structured way.

For museums to move away from the traditional approach of thinking, to be able to make extensive use of their physical space and create a familiar environment for children, specific questions need answering. As argued by Czikzentmihalyi & Hermanson (1995), a key issue for museums is how to create potential links and intersections between the interests and preferences of the visitors reflected in the everyday life of visitors and the knowledge presented in museums (Csikszentmihalyi, & Hermanson, 1995). The goal for many museums today is to try and connect kids to learning through history and artefacts. In doing so, the museums need to ask themselves the question; what does a meaningful and memorable exhibition experience for kids look like? How can we explore the “then and now” with an audience centred on the “here and now”? (McRainey & Russick, 2010). Museum curators constantly find themselves juggling with the tensions between authoritative messages and personal meaning making and education and entertainment. (Dindler, Iversen, Smith, Veerasawmy, 2010)

### 3.3 What do kids know and what do they want to know?

When looking at designing the space for the audience, in addition to understanding the development characteristics of children, it is relevant to know what they know already about the intended focus of the exhibition. With using this as an originating point, it is easier to understand children in terms of what it is that they understand currently, and then be able to move them beyond this point of initial engagement. Getting the children to engage with a story that is already known and popular to them is different than getting them to engage with an unfamiliar story. From observations it is apparent that kids are open to new ideas, but they hold onto their existing ideas, until they are given alternatives that they think are of equal or greater value.

What do kids want to do in an exhibition? We are aware that the curiosity that kids have is very persistent, and they want to know everything that there is to know. As designers we need to be able to use this as a good leverage and translate this curiosity into a tool for learning. When children are engaged in an exhibition experience they are collecting new information, which will be digested into their view of the world. If not during the visit, it will happen soon after (McRainey & Russick, 2010).
It is important to note that while adults might bring their children to a museum, expecting that they will be there to learn, this is not seen as a primary concept for a child. Learning something is seen as a bonus, when added to a positive, fun experience. The ideal situation would be for them to meet experiences and information, relating to them personally, as an element of them having fun. Kids experience the world with their bodies, minds and emotions. How is it appropriate as a designer to prepare a space for kids that acknowledges their happiness, while at the same time helping them focus on exploration and learning? Through play, young children can learn and older children can engage subject matter the best. The initial barrier of museums being boring is overcome by exhibitions that use play as a natural form of engagement (McRainey & Russick, 2010).
Learning Through Play

Play is vital in determining the right environment in museums. Children spend a large amount of their time playing with themselves or others. Children are known to learn the best, relate to others the best and have the most fun, during play. Furthermore, developmental psychologists such as Lev Vygotsky have mentioned the idea of play as a way of “scaffolding” learning, which allows children to advance from one stage of knowledge to another (Vygotsky, 1977). For play to be an effective tool to learn is true, when looking at museums, where it is encouraged to have a free choice of learning, (Falk & Dierking, 2000) as it is based on a more informal environment. If taking part in a voluntary activity such as visiting a museum, play is not substituted as a learning medium, in relation to children. Children might not play to learn, but nevertheless they do definitely learn when they play.

Locke further denotes the importance of play when learning; “When educating children, none of the things they are to learn, should ever be made a burthen to them, but instead should promote learning through play” (Locke, 1693).

4.1 The Meaning Of Play

What is play? this question isn’t easily answered as scholars that study the subject of play define it with a slightly different set of criteria. Play seems to be one of those things that are easier done and just known as opposed to defined. In his work Johan Huizinga argued that the basis of civilisation and culture lies in play. “Culture arises in the form of play... it is played from the very beginning” (Huizinga, 1970). Brian Sutton Smith who is a scholar in play, defines it as something that is understood through an exploration of ambiguities. In the Ambiguity of play, he underlined the idea that “we all play occasionally, and we all know what playing feels like. But when it comes to making theoretical statements about what play is, we fall into silliness. There is little agreement among us, and much ambiguity”. In other words it is apparent for most scholars that play is much more easily “played” as opposed to defined. When looking at the idea of play, even though it is difficult to define, we are still able to look into some characteristics of play, which help in determining the role of play in specific spaces, with museums being one.

Firstly, play is seen to be voluntary. As defined by Huizinga, “it is never a task. It is done at leisure, during free time” (Huizinga, 1970).
Secondly play is seen as being pleasurable; it is fun. When there is no laughter and happiness then there is most likely no play. Huizinga identifies that “it is precisely this fun element that characterizes the essence of play” (Huizinga, 1970).

Thirdly, play is its own end, and “the purposes it serves are external to immediate material interests or the individual satisfaction biological needs” (Huizinga, 1970). By this definition Huizinga reflects on the fact that the user is not initially participating in play because he/she thinks that they are benefiting. For instance when children play with blocks, they might be learning some geometrical, architectural or social skills, however this isn’t the reason for why they are playing as such. Instead they are playing because they just want to play with the blocks.

Fourthly, play creates a time and space for participants, which is separated from the demands and concerns of everyday life. Huizinga refers to this space as the “magic circle”. In this magic circle the rules prevalent in the normal time and space of life do not exist. When players are in this magic circle, they hold to the rules that everyone who is playing has agreed to. However, when these rules are broken, or other conditions of play not met, then people are not necessarily playing. (Huizinga, 1970)

If we were to analyse the suitability of play when creating exhibits that are based on history/culture, the features of play are similar to those that are typical of a good museum experience. In a museum experience visitors want to have choice and control. They are not obligated to do so and volunteer in participating. They also have the right to enjoyment and having fun. Museums should also give the chance to let the visitors undertake activities that take them away from the everyday world. “When visitors are focused, fully engaged and enjoying themselves, time stands still and they feel refreshed” (Rand, 2001)

It might seem quite obvious in the fact that learning occurs more readily in an environment of fun, challenge and variety. However there are concerns about the drawbacks of learning through play, especially if learning is made to be too much fun. Therefore the goal is to create not only fun environments but to create meaningful tasks so that the children take learning seriously and learn to do difficult tasks. Kay looks at the difference between soft fun (when the environment does most of the things for you) and hard fun (playing a musical instrument as opposed to listening to it), which stimulates children to “stretch and grow”. (Kay, 1998) As we know the non-informal world does focus around play, discovery and engagement. Science and children’s museums that aren’t bound to national standards are supportive to these ideas, whereby play is used as a primary learning tool. Examples of this include hands on exhibitions, engaging all the senses and methods for promoting speculation,
manipulation, experiment and imagination. More and more formal curriculums are realising that for children to develop in a positive manner they need the aspect of play in their lives.

4.2 Types Of Play

Pretend play, also known as pretence play and role-play. The power of a child’s imagination contributes widely to this type of play. An example of pretend play, in a history museum would be where children are busy “working” in a pretend kitchen from the nineteenth century. Pretend play might be seen as being unique to humans. (Mitchell, 2007)

Object play, which is another type of play is found in many interactions. The natural instinct for children is to play with things. Kids are ready to pick up objects and interact with them. Psychologists tend to differentiate between object exploration and object play, and this distinction is apparent in museums. When children explore they want to know; “what does this object do?” When they are playing they seem to be more interested in learning. “What can I do with this object?” (McRainey & Russik; 2010) Playing with objects requires activity. This activity isn't always encouraged in historical museums, where objects are housed. For children to just have to learn about artefacts that are used or were used in the past, does not engage children into object play. However, to give children the opportunity to do something with the objects or representations of the objects would promote play. This object-based learning is encouraged in the preschool setting that I have worked with and therefore also applied to the design ideas that I have chosen.

Constructive play involves using objects, to build. This is quite an active type of play, where museums have found ways in which children can be occupied to play through providing raw materials to make things. This is linked to play in a preschool environment too. This unfamiliar informal setting, in the museum becomes instantly familiar to them. Different forms of constructive play, in museums involve low-tech craft stations or architectural building areas, using blocks and computers, in virtual construction. (McRainey & Russik; 2010)

Physical play, is another type of active play. This type of play comes in many forms; such as running, chasing, twirling and jumping. These are very important types of play for children, however they aren't always encouraged in indoor museums. (Pellegrini & Smith, 1998)

Competitive play is another type of play that originates in game play, whereby players compete according to rules. This type of play can be instilled in cultural museums through teaching cultural content or through giving kids a chance to play old games from the time period that they are exploring in a history museum. (Caillois, 1962)
Collecting play, is a type of play, which indulges children quite quickly, and is something, which they can relate to quite easily in the context of museums, as many are built on collections.

Language play, parent - child play, outdoor play and technological play are some of the categories of play that are identified by scholars as a way to describe children’s play. These different types of play can be applied to these more cultural and collection museums, giving them many ways in which to make very interactive experiences. (Jon Paul & Dyson, 2009)

Play changes with age for children. Research undertaken by child psychologists, reveals that children learn locomotor and object play at first and when they reach a year and a half they begin with simple pretend play. As they get older they just pick up more complex forms of constructive, imaginative and game play.

5

Cognitive Development

5.1 Theories of Cognitive Development
5.1.1 Piaget

Jean Piaget influenced child development during the 20th century. His work has been very influential in developmental psychology and educational research. Below I will take a look at Piaget’s developmental stages of the life of a child.

5.1.1.1 Stages Of Development

Piaget’s theory of play is based on his theory of cognitive and intellectual development. According to Piaget, children undergo four stages of development and these are determined genetically.

The first is the “sensory motor”. This spans for the first two years of life. Piaget claims that infants and toddlers think with their eyes, ears, hands and other sensorimotor equipment. However, they can’t yet carry out activities mentally.

The second stage is the “pre-operational” stage, which is associated with the years between two and seven. There is an obvious increase in representational, or symbolic activity.

The third stage is referred to as the “concrete operational” stage. This spans across seven to eleven years, and marks a major turning point in cognitive development. Thought becomes much more logical, flexible and organized. It resembles the reasoning of adults more closely, than that of younger children.

The fourth stage is the “formal operational” stage. According to Piaget, around the age of eleven, young people enter this stage, and develop the capacity for abstract, systematic and scientific thinking. They no longer require concrete things or events as objects of thought. On the contrary they are able to come up with more general logical rules, through reflecting internally. (Berk, L, 2012)

5.1.2 Socio Cultural Theories

Lev Vyotsky further looked at the social aspects in children’s education, where he researched on how language and signs were crucial to the development of cognition. He found that learning was social in nature, whereby children are likely to complete tasks with some help from adults. He stressed the importance of social support systems in children’s learning. (Vygotsky, 1978). He also identified that when they are able to internalise the process that helps
These social cultural theories have followed on from Vyotsky, emphasising the fact that learning amongst children occurs when they actively interact with others, and they aren’t just mere recipients of knowledge. Knowledge is a socially constructed phenomenon. The socio cultural context is studied at two levels. One looks at the society and culture that the child is associated with, dependant on history and geographic situation. The other level looks at the learning methods provided by schools and the family, where different values lead to differences in cognitive development. (Flavell, P. H. Miller & S. A. Miller, 2002). Situativity theory is a modern socio cultural approach, where learning takes place in activities, when children interact in their environment and the people in that environment. The knowledge is created and shared out to the tools, artefacts and people, in the space as opposed to being contained individually. (Brown, Collins, and Duguid, 1998)

5.2 Symbolic Representation

By the time that children reach the age of 3 they are able to understand that a symbol is representative of something. For instance you can have an object that can be both an object as well as a symbol, representing something in the real world. Children need to be able to relate to the symbol, and be able to use information from the symbol to ascertain knowledge about what it represents (DeLoache & Smith, 1999) Children at pre school are able to use simple maps but find it difficult to understand how maps are represented (Liben & Downs, 1991). Furthermore as they get older they are more likely to put the weight of their play into language, where they plan the sequence, describing what will happen and who is who. (Greene and Hogan ,2005).

5.3 Problem Solving

Children at preschool age are known to be able to ascertain facts, even if they aren’t a true representation of the real world. An example given by Piaget was that when water was poured into a taller thinner glass, preschoolers think that it holds more water than a shorter thicker glass. (Flavell, H Miller & A. Miller, 2002) Moreover pre schoolers are likely to look into one aspect of a task or the task in hand, and don’t think about what might happen in the future or what has happened. (Flavell, H Miller & A Miller, 2002). Children at preschool age are also more likely to use qualitative measures when assessing, whereas elementary children will use more qualitative measures. (Flavell, H
Miller & A Miller, 2002) Additionally, pre schoolers are able to use their reasoning abilities when they are faced with informal tasks, involving probable facts. An example of this is when they can identify new situations with situations previously experienced. They also have knowledge of causal relationship, with the understanding that one action can trigger something else. (Flavell, H Miller & A Miller, 2002)

6

Learning Through Collections

6.1 Object Learning In Children’s Museums

Children understand the concept of collecting and this idea of collecting is a trait of many children. (Jarmon 1994). Children seem to have three interests in collections; first they are likely to acquire and own things: Do you see what I have? it’s mine”. A collection shows status for some kids. Secondly, children like to classify what they
collect, arranging and rearranging objects as they explore their physical characteristics. (Pulaski, 1980). Thirdly a collection becomes a starting point for exploring and learning. To be able to describe their collections, kids absorb polysyllabic words above their language level. Children like adults are attentive to objects, to make sense of the world around them. Individuals are constantly looking around for signs, incorporating three dimensional objects, as a source of information. (Gabriel, 2007) Once this information is visualised, it is compared to other objects that contain similar characteristics, until there is a match. For a striped furry tail, may relate to a house cat, although it belongs to a tiger in its zoo cage that the child hadn’t encountered before. (Kosslyn, S.M & Koenig, 1992) Children begin to build these visual objects in their mind from when they are born, which is essential for later learning. Moreover, when viewing and discussing objects in museums children are able to gain critical skills, in the form of emphasising with others, telling stories and sequencing events in time. (Dyson, 2006) David Carr, identifies that children’s exposure to objects increases the sophistication of their thought and communication. This then helps their ability in exploring objects with their senses and their imagination, and decides on what they mean (Carr, 2003). Moreover, displays of objects that are rich and contextual, tend to create memories that last for children. This was seen form a study conducted by Barbara Piscitelli and David Anderson, whereby they saw that children recalled particular object installations. (Piscitelli & Anderson, 2001)

6.1.1 Hands On

There has been a shift from a “hands off” approach to a “hands on” in many museums today. These museums are signified as being more boisterous, open and explorative places, when compared to the more traditional ones, taking on a completely opposite approach. “Essentially children’s museums are learning playgrounds, full of choices that encourage visitors to pursue their own interests as far as they want”. (Cleaver, 1992). In children’s discovery rooms in natural history museums, kids are free to touch stuffed animals and play with fossils. With hands on art museums, they get to see the detail behind how an impressionist painting, forms an illusion of shimmering light. (Cleaver, 1992) Although there are many museums adopting this hands on approach the need to preserve objects and historical artefacts should be understood. However, when cultural museums house objects and also try to form an environment for children it is a challenge to
strike a balance. (Cleaver, 1992) Museum professionals are nevertheless beginning to iron out the differences that exist between the more “hands on” and “hands off” museums. By blending both of these museum experiences, it is possible to create both enthusiasm for “hands on” as well as respect and understand “hands off”. Purely hands on museums are beginning to develop their own collections and introduce behind the glass exhibits, and other hands off museums are integrating interactive and touching features. (Cleaver, 1992) Portia Sperry, who is the director of the “please touch” museum in Philadelphia, outlines the goal of the museum as follows. First, visitors should be disclosed to materials that wouldn’t be available in other settings, or if familiar presented from an unusual viewpoint. Secondly, the exhibit should focus attention on the object, material or experience, using all the senses. Thirdly, in attending these museums children are motivated to learn, make choices, be flexible, have the ability to move from the familiar to the unfamiliar and to make new experiences meaningful to each child’s individual way of thinking and acting. (Cleaver, 1992) The main goal of most museums and especially children’s museums is to show how slices of life in the exhibits relate to our own lives and the world as a whole. Michael Spock defines that “everybody equates interactive with hands on, but a lot of stuff has to do with projecting your imagination. The issue is connecting with the material” (Cleaver, 1992)

6.1.2 Hands On Equals Minds On

One interesting thing about museums, which promote exploration, is that they are setup to encourage kids to discover things on their own. In this way the kids are able to gain ownership of a concept through the experience with it. Richard Gregory emphasises the role of ‘hands-on’ in ‘turning minds on’. In other words, ‘hands-on’ is not an end in itself, but a means to an end: activity and perception require the individual to apply interpretative frameworks in order to make sense of the experiences which museums provide. (Gregory, 1992). It is one thing to sit at school and read facts about South American culture and the way in which the Uros people live on lake titicaca in Bolivia. However it is different to actually be submerged into an environment in which they are able to explore and engage themselves through the tactile and sensory nature of the museum environment and imagine yourself as a Bolivian girl taking care of her brother on the boat. Facts are off course important but they remain one dimensional and unconnected to our inner selves, until they are somehow incorporated into our individual framework of
real life. (Cleaver, 1992) At a museum, which is strictly geared towards, “a hands” off approach, visitors may have many choices as to what to see but only a few ways in which they can experience the exhibit. At “a hands on” museum, the choices that visitors have are connected through the freedom of choice in how they learn at each exhibit and how to approach it. (Cleaver, 1992). Serrell also mentions that visitors choose their own path through exhibitions and, even when they follow what may be the desired flow, they rarely view every element (Serrell, 1997)

6.2 Challenges Of Object Based Exhibitions

A few museums have begun to see collections as an important tool for connecting kids to history and culture. Collections are a way of motivating curiosity - what is that? and their representations of truth and authenticity - is that real? For museum teams to make exhibitions meaningful to children they are faced with great challenges. One being to select objects that provide a foundation in creating a positive experience, to interpret the objects so that they are communicating key messages and to design a space that promotes exchanges between children, adults and artefacts (McRainey & Russick, 2010). Creative displays, multimedia and interactive experiences help children in gaining a more intimate interaction with artefacts. (McRainey & Russick, 2010)

7

Tangible Interaction Design For Museums

7.1 Children’s Learning Environment

“Computer access will penetrate all groups in society..machines that fit the human environment… using a computer as refreshing as taking a walk in the woods” (Weiser 1991). Weiser's futurist vision might not be totally realised, but it is true that technology is embedded in our everyday lives. Computers and networks are widely applied in schools, and outside of schools in museums, where computer environments have aided multimedia exhibitions.

7.2 Tangible Interfaces For Learning
There are a number of reasons for why tangible interfaces may particularly
benefit learning. Triona, Klahr and Williams comment on tangible interfaces and the use of physical materials. They say that if perception and cognition are closely interlinked, then using physical materials in learning a task might change the nature of the knowledge gained relative to that gained when interacting with virtual materials. (Marshall, 2007)

Moreover, exploratory work on tangible interfaces shows that they help in engaging children in playful learning and that novel links between physical action and digital effects might lead to increased engagement and reflection. (Marshall, 2007)

Tangible interfaces may also be suitable for collaborative learning. They can be designed to create a shared space for collaborative transactions and allow users to monitor each other’s gaze to manage interaction easier than when interacting with a graphical representation on a display. (Marshall, 2007)

Additionally, Marshall depicts two types of learning possible with tangible interfaces, exploratory and expressive activity.

Exploratory learning is where the learner examines an existing representation, which is normally based on the ideas of a teacher or expert. The learner might grasp this new information through relating it to personal experience or the model might clash with the learner’s existing level of knowledge, allowing them to rethink. Interacting with tangible systems becomes intuitive, allowing the environment to be suitable for rapidly experimenting and gaining feedback.

Two reasons for why tangible interfaces might be suitable for exploratory learning: firstly, the intuitive interaction might offer a stable environment for rapidly experimenting and gaining feedback, resulting in less focus on how the system works and more on the underlying domain. Secondly, if there is extra information about a domain or if interpretations are guided or constrained by manipulating physical materials, then there might be advantages of tangible interfaces over other learning environments. (Marshall, 2007)

Expressive activity allows learners to form an external representation of a domain, using their own ideas and understanding. Learners can make their ideas concrete and explicit using certain tools, and then analyse how closely the representation relates to the real situation.

Two reasons for why tangible interfaces might be used: firstly through recording aspects of learner interactions with physical objects, tangible interfaces can allow learners to formulate representations passively, while focusing on another task. Secondly, they are novel media, where learners can create constructions that might not be achievable in existing media.

7.3 Related Work
7.3.1 Tangibles

Fitzmaurice et al (Fitzmaurice et al, 1996) laid the foundation for a new framework for the graspable user interface. He defined a graspable user interface as a “physical handle to a virtual function where the physical handle serves as a dedicated functional manipulator”. Ullmer and Ishii from the Tangible Media Group at the MIT Media Lab, define TUI’s as “devices that give physical form to digital information, employing physical artefacts as representations and controls of the computational data (Ullmer and Ishii 2000).

Tangible User Interfaces provide physical form to digital information and computation, facilitating the direct manipulation of bits. TUI designers are looking to seamlessly combine the physical and virtual world. Tangible interfaces will make bits accessible through augmented physical surfaces (e.g. walls, desktops, ceilings, windows), graspable objects (building blocks, models, instruments) and ambient media (e.g. light, sound, airflow, water flow, kinetic sculpture) within physical environments (Shaer, Leland, Jacob, 2004)

One area, which has grown is the access and manipulation of information, where different forms are used such as mats and blocks. (Wakkary & Hatala, 2006). This looks at the idea of graspable interfaces, compiled with digital navigation and information and real world interface props. There have been other examples in games using tangibles. (Rizzo & Garzotto, 2007) Here, text, video, music and sound was integrated into the learning process. Tangibles are also built around storytelling environments in museums. An example of this is “magic story cube: an interactive tangible interface for storytelling, (Zhiying Zhou et al, 2004). The aim here is to enhance the interactions of traditional storybooks, whilst still keeping the main advantages of these traditional physical books. The examples above have used tangibles in various forms and elements of these are apparent in my final design at the museum. The children are able to manipulate the information through becoming the authors in the process. They are handling props, which in this case are the stencils and interacting with the interface which are the boxes projecting the animation and playing sound. Finally the tangibles are built around a story telling experience, whereby the end of the story is heard once all the stencils are collected and placed in the correct boxes.
7.3.2 Ubiquitous Computing

This looks at making computing available in larger spaces such as museums. An example of this was used in the hunt museum, in limerick, Ireland, where the theme was to “re-trace the past”. The idea was to see how new technologies can be used to augment educational and social interactions in public environments specifically galleries and museums. Some of the key features here included close to authentic replicas of objects for children to handle and touch and typical furnishings to be found in an old furnished room, augmented by ubiquitous computer technology. An example of this was where visitors were able to place an RFID tagged keycard on a map on the desk. The desk could then detect the location of the card on the map and provide the visitor with information about the object on the card, relating to the location on the map on which the card had been placed. (Hall & Bannon, 2005)

Existing research discussing the role and impact of interactive technologies within this domain is mainly focused on the design of information systems that provides museum visitors with large amounts of information on specific museum artifacts and exhibits. However using this approach in designing interactive installations for museums has limitations. These installations can be intrusive and distracting, undermining the appreciation of exhibits. Moreover, social interaction between the visitors isn’t necessarily supported, as most of these installations work with single user interactions, and these technologies might isolate people. (Ciofi, Cooke, Hall, Bannon; 2001-03) In contrast to this “Re-tracing the past” had the goal of engaging visitors in a meaningful and rewarding experience, rather than submerging them with information and distracting them from existing museum holdings. The exhibition was characterized by a unifying goal of engaging the visitors, where they were encouraged to reflect on the historical interpretation and
classification of artifacts, without having to replace any existing resources that the museum offered. (Ciofi, Cooke, Hall, Bannon; 2001-03) This element of ubiquitous computing focuses on the experiential qualities of the museum, rather than visitor’s activities or behaviors, such as visitor relationships with others and with the place and the artifacts that they explore. The hunt museum was designed to support different layers of activity; with the idea that participants would be able to engage in a progressive sequence of actions, to provide new surprises and discoveries. (Ciofi & Bannon, 2002) Moreover, the exhibition looks at ways of supporting interaction with and around the exhibition, which is specifically collaborative. The idea is therefore to create a sense of engagement for the visitors and a seamless transition between the existing collections and the “living exhibition” (Ciofi & Bannon, 2002).

In critically assessing my final design concept I think it has a close link to incorporating, ubiquitous computing. Whereas the hunt museum has used technologies to augment social interactions through retracing the past and creating collaboration, my design has also used technologies as a way of bringing together children through maintaining one purpose of a treasure hunt. This social interaction becomes clear when the children navigate the physical museum setting, where they are looking for the same stencil and cooperate to solve the problem together. The element of ubiquitous computing becomes apparent, through the feedback achieved, through the computer technology. This level of ubiquitous computing allows specific conditions to exist. For instance if the wrong stencil is placed in the wrong box, then there is no feedback. However, if in contrast it is placed in the right box, then there is feedback of light animation and sound. In using representations of the objects to achieve this feedback, like at the hunt museum, the children are engaged and gain a rewarding experience, leading to a continuous transition between the existing collections and the treasure hunt.

7.3.3 Other Computing Devices

As museums have become more interactive the need for handheld devices to help with creating interactions has been evident. Examples of these include ways in using mobile devices to bring pre schools and museums closer in way of teaching. This can be seen in the case study looking at creating a virtual world between the two organisations. (Ibáñez & Naya, 2012) This integrated educational space includes not just the exploration of an exhibition, but also talks from museum personnel, simulations and educational work in the form of quests, within a multi user environment. Another example is of an educated game mediated by mobile technology, which is designed for use in the context of a traditional historical museum by young children. So in this way the mobile technology supports play in the museum, instead of just viewing in the way that we are used to. (Yiannoutsoua, Papadimitrioua, Komisa, Avourisb ,2009 )
7.4 Making History and Culture Interactive.

The Sensing Chicago exhibition at the Chicago history museum and the redesign of the national canal museum in Easton, Pennsylvania are two examples of interactive exhibitions at cultural and history museums. (McRainey & Russick, 2010) The original idea was to provide a history, content and collection experience which was driven by interactivity. Exhibition interactives are seen as elements within a traditional exhibition - a device engaging minds, bodies and emotions within a particular area. They can emphasize a concept, an experiential illustration or provide further explanation of an idea, mechanism or process. They can create opportunities for group interaction and discussion or simply change the pace and style of the exhibition experience. (McRainey & Russick, 2010)

Sound lab was an interactive gallery, which was part of an Experience Music Project, in Seattle, providing an experience of what it was like to play in rock band in the 1960’s (McRainey & Russick, 2010). As Hughes points out “the movement of good interactive moves the story forward. Visitors reach into a well and pull up a bucket full of water content, visitors turn the page of a diary to show the authors notes on the back, or sweep away sand to reveal a hidden flat fish. The visitors actions uniquely move the story forward”. (McRainey & Russick, 2010) The idea of making history interactive is to allow the individual to engage into the context of the environment, which they are in. It is the action of the visitors, which helps unveil the story. It is just this feeling of curiosity that I am trying to establish in my design concept. The idea is that the storyline, which encapsulates the treasure hunt is based on the history and culture evident in the objects displayed. The children are then able to move the story forward and ultimately hear the end of the hidden story, from interacting with the representations of these objects. The tangible objects enable them to engage in the here and now and provide them with an explanation of a process as they find the missing links. They are then able to recall these objects and become part of the story when retracing the steps in the story.
Storytelling In A Collaborative Environment

8.1 Children and Storytelling

Storytelling, is the process of creating narrative structure or of engaging with children is pervasive in a number of areas of their lives. Storytelling is a way of supporting a child’s development, to help them express and assign meaning to the world, to develop communication, recognition and recall skills. For children starting at primary school, storytelling is used to improve linguistic abilities and develop interpretation, synthesis and analysis. (Garzotto, Paolini, Sabiescu, 2010) Furthermore stories allow children to understand sequencing, causation, temporal and spatial perspective, the difference between what is in their mind and what is in the mind of the listener and also
allowing for organising abstract forms, such as concepts. (Greene & Hogan, 2005)

Storytelling is more than a powerful way for children to communicate, to express and share their thoughts and feelings, it is also an intricate part of the learning process (Bruchac 1987; Gish 1996; Goldman 1998)

8.2 The Physical Storytelling Environment

Many museum installations are physical interactive storytelling environments. This physical storytelling environment is referred to as a story room, and in one of these environments individuals get involved in pressing buttons, pulling strings, listening to music, watching a movie clip. (Alborzi et al, 2000) Story rooms provide an educational, experimental and fun environment, where children are motivated to make things, turn abstract concepts into concrete objects and collaborate. It is through this constructive process that they make sense of their mental models of the world. (Papert,1993) With new tools such as sensors and effectors, child authors are able to add a sense of magic to their play. When considering such environments however, it is important to remember that children have to feel in control (Strommen, 1998) and also that a growing child’s physical coordination is not like that of an adult. (Thomas,1980) The physical spaces therefore need to be refined to allow the children to feel as if they are in control. To do this it might be appropriate to show them where these devices are located and how they can be activated. Physical spaces might also need to be more rugged and flexible to allow for the likelihood of harsher use. (Montemayor, 2004) An example of a story room was that at the John Hopkins University, where children got involved in creating the physical story telling environment. Firstly they verbally developed the story, then made or found props to support the story and finally arranged the props with physical icons such as sensors and actuators. StoryMat is another example of where children can incorporate their physical space with storytelling. (Ryokai and Cassell, 1999). This is a child driven play space, where children can record and recall narrative voices and is supported by the movements of their toys on the mat.

Fig 4: Story room in progress
8.3 Storytelling, Objects and Collections

Every object in our lives has a story to tell. There is rich history embedded in objects and stories. People use possessions and personal artefacts to construct personal narratives. (Hoskins, 1998) In cultural heritage and museum studies, collections of artefacts are touchstones for preserving historical knowledge. Objects are therefore seen as more than items serving a functional purpose. They provide a link to meanings and associations that we might make. These object stories potentially awaken deep personal narrative associations and it is the objects that are important in creating these meanings in stories. (Tanenbaum, J, Tanenbaum, K, Antle, 2010).

The reading glove is an example of where the design space was made to create an interactive object based narrative, providing an interface that leveraged natural exploratory behaviours.

Furthermore as history museums have begun to offer object-based experiences, for children specifically, they have used storytelling as a tool for interpretation, to link to collections. An example of this is the Abby Aldrich Rockefeller Museum where “The Down on the Farm Exhibition” relates the travels of Prince. The story of the prince wandering the countryside in search of his cousin is told in verse. Kids follow these adventures through reading book pages. The paintings and drawings illustrate the story, with copper weathervanes and whimsical wooden sculptures of farm animals. (McRainy and Russick, 2010)

As I have touched upon earlier it is through the story telling that children are able to relate to the objects and collections present. When the children are engaged in my final design concept of the treasure hunt their primary intention is to find the cards which correspond to the objects and put them in the correct boxes as quickly as possible, so that they can hear the end of the story. To create a playful experience within a story telling environment enables the children to establish links, as they are able to attach meaning to the objects and make interpretations. The story not only brings together the objects, but is a representation of reality present in history and culture. For instance when the children hear part of the story where Irene, who lives in Africa has to get on a boat to cross over the water to get to an island, and then see the representation of this boat behind a glass box, they are immediately able to understand that this is a specific boat in Africa. The play is apparent within children at first and learning unfolds as the story develops.
9

Design Methodology

I conducted numerous workshops to help in the iterative data gathering process, referred to as “Research Through Design” by Zimmerman, Forlizzi & Evenson, 2007). The design process concentrated on involving children as informants to achieve the goal of implementing a design solution, which ultimately met the needs of the children, within a learning perspective. I was able to implement a design cycle, which focused on three main areas of activity. The first was “educational”, where I assisted the children in acquiring knowledge of the concept related to the project. In the second phase of “evaluation”, the children were exposed to, and able to analyse aspects of the prototypes. The third phase involved “brainstorming” through sketching and building. Moreover, I conducted the workshops in the field, both at the museum and the preschool. It was important to be able to get exposure to both environments at different stages of the design process. The idea generation was most productive in their preschool environment, but for the users to be able to contextualise the experience, it was important to have the prototype in place at the museum.

9.1 The Participatory Design Process
The goal of Participatory Design is to integrate “systemic analysis, appreciative intervention, and practitioner participation” (Karasti, 2001) to create social-technical-political conditions that reduce the gap between design practices and users’. Furthermore Participatory methods are those that facilitate the process of knowledge production, as opposed to knowledge gathering. According to Chambers, methods should fit the traditional balance from closed to open, from individual to group, from verbal to visual, from measuring to comparing. (Chambers, 1997)

Furthermore, Druin describes four roles which the child can take on in the design process; User, Tester, Informant or Design Partner. Although I have mentioned these earlier, it is appropriate to identify the roles in a little more detail.

The first is that of the “User”. Here the child is the user of the technology while the adult tries to understand the child’s activities using various methods. During this time children are likely to be observed, videotaped and tested before and after they have used the technology. The reason for doing this is to see the effect that the technology has had on the child’s experience. The two reasons for why researchers ask children to take on this role is to, test a general concept that may contribute to helping inform technology developers in the future and to understand the process of learning, contributing to educational practises in the future. (Druin, 2002)

The second role of the “Tester” is used for children to test prototypes of upcoming technologies. The goal is to help in shaping new technologies before the commercial products or research projects have been released. Children play a role in developing new technologies that may lead to certain product decisions and new educational theories in the future. (Druin, 2002)

As “Informants” children are observed with existing technologies or asked for input on paper sketches. After the technology is developed children are likely to give input and feedback. Children play a role at various stages of the design process, based on what researchers think children can inform them of. As a result there are numerous dimensions underlying this role, in relation to a child’s connection to adults, technology and goals for inquiry. (Druin, 2002)

The role of a “Design Partner” is similar to that of an informant. The difference being that as a design partner children can be part of the research and design process throughout the experience. Children are seen as being equal stakeholders, when designing new technologies. Even though children aren’t able to do all that an adult can, they have the opportunity to contribute equally. Moreover child researchers are seen to have unique experiences that are capable of supporting the design process, that other design partners may not be able to contribute. In this role the child’s relationship to adults and
9.1.1 Critical Analysis Of Participatory Design & New Technologies

As a critique to research efforts aimed at the development of new technologies it is fair to draw upon Taxén’s (Taxen, 2004) argument that research efforts in children’s participation tend to focus primarily on the development of new technologies and do not include aspects related to the exhibition content or the exhibition space. It is this view that has contributed in gaining a critical perspective in my design process.

It is also important to note that team dynamics are seen to have an influence on children’s participation (Druin, 1999), when it comes to prototyping. For instance a single adult in a group of several children can form team dynamics, which feels more like a classroom, reducing productivity. Moreover it is evidenced that a single child isn’t productive in a collaborative design experience either (Druin, 1999).

It is also appropriate to mention that there is the problem of imitation amongst children. Read and colleagues have argued that children are likely to change their designs based on what other children have ideated (Read, Horton, Mazzone, 2005).

Additionally, it is also important to note that children have their own likes, dislikes, curiosities and needs that aren’t the same as teachers or their parents. We as the designers of new technologies for children sometimes forget that young people are not “just short adults” but an entirely different user population, with their individual culture, norms and complexities (Berman 1977). However at the same time it is common for developers of new technologies to ask parents and teachers what they think their children or students may need, rather than ask the children directly (Druin 1996, Druin et al. 1999). This might be based on the fact that we traditionally know the adults to be the ones that know the answers to the questions and children are
the ones learning. These relationships are likely to make it difficult for children to voice their opinions when it comes to deciding which technologies to use. Moreover, we as designers also have our own biases and assumptions about children. We might also have our assumptions about learning theories and educational strategies, based on the years of schooling that we have had to go through (Papert 1972, Solomon 1986, Druin and Solomon 1996).

When developing new technologies for children, there is a huge amount of personal experience about young people that we choose to use. However, these personal impressions may not be so supportive of children. They are quickly becoming the power users, of the internet and other multimedia tools (Fulton 1997). Moreover, they still need to be put through academic learning and live in the complexities that exist in the world. It is also apparent that young children have a more difficult time verbalising their thoughts, especially when related to abstract concepts and actions (Piaget 1971, 1973). For instance if an adult asks a child to do a task and he/she becomes bored, they may just walk away, distract another child or just sit there. They are “acting out” as opposed to confronting an issue like an adult might, through discussion. Adults might misinterpret this behaviour, as they think that children have a limited attention span, are uninterested in co-operating or are destructive. Children are very honest with their feedback, but a lot of what they say might be in their actions and for this reason need to be interpreted within a concrete experience (Druin 1999). For the reasons above, a child’s role in the design of new technology has historically been minimized.

9.2 Children As Informants

Kids are believed to be involved in the design process as more than reactive critics because they have much to say about motivational expectations that we as adults simply don’t have good intuitions about. However we don’t treat kids as full partners either as it is apparent as to how much they can be involved, with respect to the limitation on their knowledge, time and experience. (Scaife and Rogers, 1999) It is also important to note that whilst children are good at expressing what motivates them in a learning context, we should weigh up and integrate the different contributions that children might have but at the same time it is unrealistic to take every contribution on board. The design team have to decide how they fit together and whether the projects objectives are fulfilled. (Scaife and Rogers, 1999). Moreover it is ideal to specify an effective method for involving different individuals in the design process at different stages. This means that the different phases of design need to be determined with identifying who will be
the informants in these, what their inputs will be and what methods will be used. Therefore our interactions with children can formulate our view of them as informants. This would therefore lead us to discover what we didn’t know rather than confirming what we already knew. (Scaife and Rogers, 1999)

9.3 My Design Methodology

The children acted as “Informants”, in my design process and the objective was to maintain consistent input and interaction with the children, teachers and prototypes. The idea was to develop an open dialogue with the children and for them to communicate their experiences throughout the design process. However, the intention was for me to act as the gatekeeper with making the decisions to when the feedback is given. This enabled me to keep a balance between the more traditional reactive role of the user and posing the same responsibilities as researchers. To make them reflect on experiences and provide a reasonable contribution to the learning goals it was important for me to expose them to the museum setting, in the initial workshop. When the children were in an informal setting of the museum I was able to observe them in an environment that was natural to their instinctual behaviour. They were then able to take this experience to their comfortable setting and reflect upon it. George Forman and Ellen Hall (Forman & Hall, 2005) detailed 5 understandings from observing a child’s behaviour; interests, skills, level of social and cognitive development, their strategies for pursuing desired effects and personalities and temperaments. Moreover this initial workshop involved a physical participation, which took place and a consumption of the interactions that were available with the movement away from an “Informant” role and more towards a “User” role. However the reflective experience of the children came to the surface when they discussed their thoughts, with likes and dislikes, after participating in the museum exhibition.

The children’s informant skills were further tested during the “Cultural Probe” exercise, which was an approach to gaining contextually- sensitive information, to inspire the design of new technology (Gaver & Dunne, 1999), for the museum, in later workshops. During this exercise I asked the children to draw as a method of translating their experiences. Drawings can be communicative, but also in their production, pictures are discovered.
(Andersson, 1994) Therefore it is apparent that it is this capacity of drawing to bring something into meaning that is of interest here. The children were able to combine their more familiar worlds with the unfamiliar world, to try and make sense of the more unfamiliar new perspectives. It was also interesting to see how the children spent their time in outlining the fine details in their drawings and spent little time on how the characters or objects in their drawings would interact and behave. (Gardner, 1982) A further observation through their participation, showed me how they tended to copy others when they weren’t entirely sure about what they were meant to do. This then led me to varying the design process and having the children actually participate through building as well as sketching and extend their informative skills in this way. Through doing this they were able to think about the interactions as they were thinking with a more 3D perspective and, the use of motion was inspiring in developing ideas too. They were able to outline the elements of “Play” and “Navigation” to a greater degree, with the focus on Use qualities.

During the final stages of conceptualising, the children were involved in testing the prototypes and offering their feedback on what they thought was interesting. During the exploratory workshop, the children moved along the spectrum, with a co designing stage, whereby they made the decision to where they were to place the cards representing the educational artefacts. I wanted the children to come up with their own ideas of where they think the cards should be placed. This was important to see and provided more insight to the design process as opposed to having them just react to the prototypes. Overall these low fi prototyping sessions showed me how it was possible for me to work closely with the children and to gain an understanding of their more imaginative world. They were able to express which prototype they would like to use again and also why they would be interested in using it again. It was however also apparent that they weren’t always aware of the learning element and maintained the primary motive of having fun.

In critically analysing the Participative Design method it is apparent that this choice of method was able to show the transparency of the children’s work, enough to be able to incorporate their “needs” into the final design. We can see that a few themes arose as a result of the methodology and from this I was able to make definitive decisions in how to proceed forward. The idea that the children were able to incorporate the unfamiliar into their familiar surroundings when sketching enabled me to design the final product with elements of problem solving and connecting things through play, using tangible objects in the not so familiar setting of a museum. Another element, which was apparent during participation, was that when the children copied each other. This occurred when they were unsure about the specifications of
the task. The children were therefore seen to collaborate and work as a team when they were worried about getting something wrong. I was able to incorporate this in the final design, whereby the treasure hunt became more of a collaborative game, and they had to work together to reach the final goal. As the children were in an unfamiliar setting, they were a little unsure about their surroundings and this meant that they followed each other around the museum, but at the same time maintained a shared goal of finding the stencils and the intention to have fun and play.

The participatory design method however wasn’t always so transparent with yielding positive results. The children were able to directly impact the final design result in many ways, when using skills in sketching, building and when actually becoming the users. However, participatory design methods become challenging when we as adults can’t always envisage the results and expect children to react a certain way. We of course shouldn’t have these judgements but these may take precedence in some cases. In this particular instance I had to change my perception of how each activity performed would always yield a positive design outcome, and how one situation would lead to a specific outcome. During the process there were a few children that performed better at some tasks compared to others. This became reflective of their abilities in certain situations and also ascertained that they couldn’t be as expressive at everything. The findings in cases like this were much more difficult to extract, therefore impacting the final result. However at the same time, I was able to analyse my final design more closely, when exposed to different skillsets and this became an important element in the participatory design process. Moreover, through bringing everyone together in a storytelling environment, attention is focused on a collaborative environment. However, we are also faced with a challenge where children might not want to participate. The treasure hunt is designed to give the children the freedom to take on the authorship or to become more passive in their surroundings, but in each case they are given the opportunity to learn.

During the design process I was also able to use activities, which built on other tasks. As there was no definitive outcome I used a more fluid approach and decided on which tasks to incorporate next, once previous tasks were analysed. As the process progressed to the latter workshops I was also able to frame the setting in a different way to what I did in the beginning. The manner in which to address the children became clearer, the further I progressed. I also used different spectrums of the participatory design process, whereby the children moved from becoming testers to co designing. However at the same time I was aware that I would have to adapt to the children, depending on their individual skill sets and the task at hand. In becoming aware of the volatile nature of this design method and the various degrees of understanding and complexities of relationships I was able to build
a good rapport with the institutions, children and teachers and ascertain the relevant information for my final design.

10

The Design Process

10.1 The International Pre School

10.1.1 First Observation

When I began the process I initially undertook observations to just watch how the children interact with each other and with the teachers. Observing was a good way for me to ease into their comfort zone, with the aim of letting them become comfortable with me before conducting any experiments with them. During their free play-time I observed a range of capabilities and interactions that took place. Free play allowed the children to explore their own boundaries by “learning through doing”. They were surrounded by possibilities, ranging from jigsaw puzzles, board games, building blocks and lego. I observed how some children were happy playing on their own and having the control to build the way they wanted, while others played in a group, when trying to problem solve. The group dynamics revealed that there was always one child that tried to take control in making the decisions or naturally led the group. Some in the same group would be more passive and copy what the “leader” of the group decided on. On the other hand at times if there were more than 4 children playing together, it meant that the mixed personalities clashed.

In the morning the teacher decided that they would dance to some music. She believed that participation was key in making the children adapt to the environment. There were a few kids that hadn’t spoken much, during circle time that morning, however they were much more confident after they had danced and articulated themselves easily when questions were directed at them.

In the afternoon we had “circle time”, which helped us share our thoughts and experiences. I began a discussion about culture and the children’s respective countries, for me to see how they conceptualised their world. How could I learn about your country if you were to tell me a story? Through maps, different ways of eating, different clothes were typical answers. They weren’t aware of distance and the concept of time and not entirely sure about which type of food came from which country but they were
aware of the fact that differences did exist and were able to relate to their reality to formulate these differences. It was also apparent that expression and feeling existed amongst the children, regardless of the language barrier. This expression also made room for a disciplined environment, and the feeling of being rewarded and feeling important. The environment also fostered respect for others.

10.1.2 Discussion With Teacher

The teachers change the environment constantly. The children will take part in taught sessions as well as more free sessions where they get to make decisions about what they play with and do in that time. This variation in the day helps in making them more creative and thinking outside of the box. Moreover, the teachers promote a constant change in environment from the inside to the outside, and also like to change dynamics through bringing nature from the outside, inside. The children get to go on weekly excursions to museums or cultural institutions and in this way are constantly exposed to this changing environment.

10.2 Design Workshops

I undertook my approach by firstly carrying out 3 workshops, which were related to experiments, which helped in my discovery regarding the children’s needs. I carried out the discovery workshops in both the museum and at the pre school, which helped in defining the prototypes that I would test on the children. Through the initial three workshops I was able to establish particular themes that were relevant to the specific prototypes to be tested. Exploration and Play were two important elements that were seen to a greater or lesser degree in all three prototypes that were tested.
10.2.1 Trip To The Museum

The first exploration workshop involved a trip to the “Earthlings” exhibition at The Världskulturmuseerna.

The intention was to observe the children’s interactions in the informal museum (as opposed to the formal preschool), which would provide me with more design specific findings. Questions relevant to the analysis might be, what are they attracted to? Is it sound? Light? Touch? Does this learning take place in more of a digital or physical environment?

To achieve a greater learning experience the children role-played as aliens from Mars, who were on earth to find out how the earthlings live. To help in immersing the children in this roleplay I dressed up as one of the martians and videoed myself, calling from Mars. I mentioned that they were to report their findings from the museum, back to Mars when they return. At this point they were involved in “Pretend play” (Mitchel 2007)

Fig 6: The kids listening and watching a video from the martian

10.2.1.1 Analysis

One analytical point was to see how the children’s reactive patterns changed based on icons, which helped determine what was familiar to their world. An example of something, which was not familiar to them was the “no entry” sign. Furthermore, as Deloache (Deloache & Smith, 1999) cites, “children need to be able to depict the information that the sign is representing from the actual sign”, and here the children were able to separate the background from the minus symbol, and couldn’t see the representation of the sign as a whole.

They spent a lot of their time running around, jumping on cushions and just exploring. Additionally when asked a specific question on how something worked they wanted to know the answer. They spent some time in trying to resolve a pattern that might exist or formulate a story. They were also very curious and interested in getting closer to objects that were of interest. Moreover, the element of play was heightened when they had the chance to have fun and control the outcome.
After the trip to the exhibit I asked them to sketch themselves at their favourite part of the museum. Most of them drew themselves exploring, through following a path, tunnels and arches.

One specific sketch represented a mask, which was shaped like a caterpillar, and moved towards a girl when she jumped. Here an action was depicted and “doing” something triggered movement. This relates to the causal relationship that Flavell and Miller mention (Flavell & Miller, 2002), as cited earlier in my text, whereby children at this age can understand how doing one thing can lead to another thing happening. Another girl drew an alien mask and showed how she was inside space, which was unfamiliar to her. She then drew a path leading to music, which was more familiar to her. An analysis of this particular sketch shows how a relation was made to the familiar world, but at the same time the curiosity of the unfamiliar world was also depicted.

Overall the children were able to use their storytelling skills, imagination, play and senses at the exhibition and as a result were very happy with the experience. Their participation in the actual setting gave very positive results, as they were able to have a “hands on” experience and talk through this experience during and after the activities. They were able to express the first hand experience more openly as this was now reality to them. They also reacted to some elements at the museum from drawing on previous experiences and trying to create meaning, based on these representations.

10.2.2 Cultural Probes

Probes are a new approach to gaining contextually- sensitive information in order to inform and inspire the design of new technology (Gaver & Dunne, 1999). Gaver sees cultural probes as an instrument to “discover the unknown” (Gaver, 2004) It has been discovered that probes may be used to discover new ways to leverage children’s natural interests, their likes and dislikes, and passions and are consequently useful in inspiring the design of new technology. (Wyeth & Diercke, 2006)
10.2.2 (a) Exercise 1

The cultural probes exercise helped me engage into the children’s perceptions and to maybe understand things from a different angle and add to my observations made at the museum exhibit. I conducted another role play and put six different sheets of coloured paper, each with a question, inside each box. They had pens, pencils, glue and additional craft material included as well. The boxes were distributed to every child and they were sent down by the martians from mars. The idea of this role play was to try and help the children to tap into their imagination as much as possible and reflect on their actions. The martians needed answers to specific questions, that were mainly pointed towards the earthlings, living on earth. I wrapped the boxes in tin foil paper so that they would be representative of another planet. I was then able to follow this on from the theme that we had started at the museum.

As the children were comfortable with the environment of the preschool we carried out the probe exercise at the preschool. They sketched their answers to the following questions, following a discussion.

1. What is important to you?
2. Make a gadget for the martians in mars, for them to see how the earthlings live
3. Draw a dream planet. Are there trees, water and cars?
4. Draw you and your family, if you were aliens
5. Make a spaceship
6. Draw; nature fear, home, music and signs

10.2.2 (b) Exercise 2
The second session involved circle time, with a discussion around some specific questions:

1. What did you like about the exhibition?
2. What didn’t you like about the exhibition?
3. What would you tell your friends when you go back to space?
4. What did you see? How do humans live?

I felt that it was important to try and gain their knowledge through different mediums as children at this age have different interests and individual learning methods. Some are better at sketching, others at building and some at expressing verbally. Through my research studies I felt that it was important to be open to different perspectives when analysing children’s behaviour. Too many times psychological perspectives focus on age related competencies at the expense of what it means to be a child. It is argued by some that the developmental approach can lead to a detached and impoverished understanding of children’s needs. (Diane Hogan, 2005) In this case I thought that it was relevant to work with a wide spectrum of activities and not just understand the processes of change with age. Other factors such as social and cultural aspects come into play too.

10.2.2.1 Analysis

Analysis from this workshop showed that the children were able to draw something through the representation of their own world. When they were aware of this world they were able to make a sketch more abstract and interesting but when they weren’t aware of this representation they had to ask questions and tended to copy what was mentioned. This was the case when they were asked to draw a gadget. They were also able to bring familiarity to their drawings, such as the flower spaceship. (see fig 12)

Additionally, “play” was a theme, which arose in most of the questions. One sketch brought together the element of fun and play where “play” wasn’t necessarily the main focus (see fig 11).

As I mentioned earlier one girl misinterpreted the idea of a dream planet and drew her bed instead. As adults it is far too easy for us to think that children understand what we mean. For adults the word dream is set in the context in which we relate it to but for a child that context might not exist. For instance she might not have understood the word “planet” but did understand “dream” and then put it into context of her sleeping and dreaming. When looking at developmental psychology some criticize the field in the way that children are conceptualized and therefore researched, as though they have
an existence that can be divorced from the context in which they live. At this point it is worth mentioning that as a researcher, us adults bring to our encounters with children a particular package of attitudes and feelings, which are formulated through our own personal childhood history. (Greene and Hogan, 2005)

Fig 11: alien family with feather  Fig 12: flower spaceship  Fig 13: A dream

Again their idea of play, activity and interests were incorporated in their drawings to the question “what is important to you?” From the sketches I was able to see that they were able to really represent what they were thinking in very creative ways, with some being more abstract over others. They were able to analyse different aspects in their drawings and formulate a story. Of course the drawings were much clearer to me when I asked them to show me what they had done. If asked the question “why is it that you did this”? As the question was quite closed they mostly just replied, “because I like it”. Children at preschool age are not easily able to reflect on their experiences as well as older children and this reflection is gained through activity, in most cases. In this case I saw the importance of undertaking creative workshops, but at the same time it is important to remember the way in which particular questions are asked. The more open ended the question the more varied the feedback. From having understood the differences in children’s perspectives, compared to adults I became familiar with the approach that I would have to take to formulate effective results and I was able to structure the later workshops in such a way.

10.2.3 Showing Objects & Building

This workshop was split into two tasks. The first involved educational artefacts and the second was based on designing a museum. The aim of this workshop was to firstly show them the props and then to see how they incorporate these props into their storytelling and museum building. Do they use the objects to
help formulate a play element, like they did in their sketching? If so how do they do this?

10.2.3 (a) Exercise 1

I began by presenting the props to the children. They were able to touch them and play them. The props ranged from musical instruments from different countries to some other more practical objects. They were then meant to sketch a story and reflect on the props that they had in front of them. These props didn’t have to represent the original purpose. The idea was to embrace an open ended and creative environment amongst the children, and for me to gain an understanding of the tangible interaction that occurred. Did they become more engaged and remember the objects afterwards? How did they incorporate these objects into their sketches?

10.2.3 (b) Exercise 2

The second task involved the children making a museum of their choice. There were no specific guidelines as such. They had material to build in the shape of foam, cardboard, lego, paper, tape, glue and additional craft pieces. The task was framed through the following questions: “what it is that you would like to see in an exhibition”? “what is it that you would like to do in that same exhibition”? The idea of altering the task from sketching to building was to try and unveil other creative tasks that might exist amongst the group. Moreover, with my focus being to design an end product for the children in a museum, I wanted to be able to gain input on what was important to them and I saw this as a positive contribution given the fact that they like the tactile nature in things. Additionally, experiential learning is encouraged at the preschool and the teachers were also very enthusiastic about introducing this element into the workshop.

10.2.3.1 Analysis

10.2.3.1 (a) Sketching

When analysing the sketches I observed that once the children had seen more familiar items, they were able to sketch a story with the object as the focus, such as a boat in a storm. However in some instances the unfamiliar
objects were just placed in the sketch and became part of the story as something in the background. Some children were able to incorporate the objects into their drawings and either use the objects to replace the original item or use the function of an object and represent it in a different form. For instance the boats were visualised differently and in some cases the familiar and unfamiliar elements were combined. Additionally one sketch saw how a bell was used, for a different purpose, and still sketched in the same form (fig 14). Another sketch saw how a bell was used for the same purpose, but instead sketched in a different form (fig 16). From this analysis it is interesting to see the abstraction levels of a child. Based on Piaget’s cognitive development stages children lack abstraction at this age. However revision of this theory has shown that children can display competencies at substantially earlier ages than he had believed. (McGarrigle & Donaldson, 1974)

To summarise, the children were able to use the objects, in a story in different ways, creating a level of abstraction. The idea of abstraction and storytelling was an important element to take further into the final design concept.

10.2.3.1 (b) Building the museum

The idea of play was essential in their museums and the constructions represented being very active through jumping, sliding and spinning. Moreover, interactions came into play when you had to navigate from one place to another and when connections were made where doing one thing meant triggering another. The children used all the possible props to make their museums and created stories whilst using them. During building their museums all the children were fully engaged and were very creative.
However, there was one girl who wasn’t so inclined to build a museum but was really good at sketching and had very good imagination for that instead. This brings us to the question regarding the skill in participation. With involving children in the design process as adults we have certain expectations and because of our authoritative role as teachers and researchers we are under the impression that children will ultimately do what is asked of them. However, the reason for why the child didn’t participate isn’t completely clear but I do know that she wasn’t comfortable with the task at hand. Therefore, I understood that when undertaking a participatory design process, (especially with children at preschool age) it is important to maintain a balance and understand that it is difficult to expect all of the users at the same age to contribute in the same way and this is something which I became aware of in further experiments.

To summarize, the children incorporated play, problem solving and story telling into their museums. These elements were used in the theme of navigation for the final concept. This was apparent because when playing they moved from one place to another, where they tried connecting things. The figures below show how you would have to jump from one colored ball (fig 17) or foam piece (fig 18) to another to gain feedback.

![fig 17: problem solving museum](image1)

![fig 18: play museum](image2)

11

Turning Knowledge Into Action

11.1 Learning From The Experiments

From having undertaken the exploration workshops, I was able to generate a focus and conceptualise, enabling me to prototype three concepts.
These concepts were based on some themes arising from previous workshops with the children. These themes were based on play, navigation, storytelling, The familiar and the unfamiliar and problem solving.

Play was seen throughout the workshops whereby the children were involved in making their experience as fun as possible and the idea of play was always central to this.

Navigation was an aspect that was apparent during their time at the museum and when they built their own museums at the pre-school.

Story telling was again seen in the museum when the children navigated a space, where they established control and authorship. Moreover when I asked them questions during the “cultural probe” workshop they responded to questions, through the idea of telling a story.

The familiar v’s unfamiliar theme arose from when showcasing historical artefacts from the museum collection. These artefacts were unfamiliar to them and they combined these unfamiliar objects with their familiar world, through sketching.

The theme of problem solving again arose from when the children were navigating where they made connections and determined a causal effect. Moreover, they were involved in depicting this theme when creating their own museums.

11.2 Visual Jigsaw - Unfamiliar V’s Familiar

As we are aware a child sees things differently to an adult and attaches meaning to things, through what is familiar in his/her world. It is this element, which helps contribute to the grounding to why children make specific decisions.

From these findings I developed a prototype whereby they were able to see a representation of their familiar world and also learn about the not so familiar cultural artefacts. The prototype involved a physical jigsaw puzzle, where the pieces, when put together formed an artefact, for instance an African drum. As the child physically connected the individual pieces, this was mirrored on a digital screen in front of them. However, what they saw on the screen was something more familiar, such as their favourite cartoon.
character. They were then able to discover what they saw on the screen and also what they saw in their physical space simultaneously and use the digital to help with the physical or vice versa.

The second experiment added another layer to the first. We taped together the individual pieces and the children were able to move their characters in a story scape representing Space.

The third experiment required the children to sketch a story from the objects that they saw in the digital and physical space.

11.2.1 Analysis

This environment maintained attention, as they were involved in solving a problem and watch their task unfold on a digital space. This combined both the physical and digital, allowing them to experience the tangibility of the jigsaw pieces and create the content and then visualise the output as a response to this content creation. In seeing the separation of the familiar and unfamiliar objects, they were able to form representations and create meaning through association. For instance they would remember what the African drum looked like visually as they represented this with a cartoon alien. They were able to bring both the familiar and unfamiliar world into their sketches and also change the context of the story narrative by trying to push the boundaries through combining things that didn’t make sense in the real world. They were however more interested in looking at the digital screen as opposed to the physical jigsaw pieces so it might have been a greater learning experience for the children if the artefact was unveiled on the screen as opposed to the cartoon character.

fig 19: wardrobe/instrument

fig 20: familiar v’s unfamiliar Jigsaw

11.3. Treasure Hunt - Navigation through Storytelling

The navigation and storytelling theme developed a design grounding for the treasure hunt prototype. Storytelling is central for children at preschool age and it is depicted in the approach to sketches whereby the teacher asks them to “tell a story” when she wants them to explain something. Furthermore,
when at the museum, the children took ownership and acted under “make believe”, when trying to uncover answers. They were then able to navigate through the museum, through play, where they just ran from one place to another and had “fun” and through trying to make sense of the situation, through formulating a pattern. The treasure hunt was developed as a response to their play and navigation and a storytelling element was used to achieve the correct setup. The hunt took place in the museum, whereby I hid the educational objects in different parts of the exhibition with picture cards representing those objects. I designed this concept around a story about a girl named Irene, who was lost in the woods in Africa and couldn’t find her way home. The kids were then to find the cards, from what they remembered in the story and bring these cards back to a space with two large sheets of coloured paper, one red and the other blue, with the colours being reflective of the cards that they were to find. In this particular design process I wanted to leave some activities open for the children to decide, so they weren’t told about where to place their cards specifically. After they had collected all the cards we sat down in a group and used the cards to fill the gaps in the story, simultaneously listening to the sound related to the object.

11.3.1 Analysis

The children’s behaviour of wanting to find the cards as quick as possible was reflective of the space they were in and the people that they were surrounded by. This can be related to the aspect of storytelling for instance. From my previous observations I had noticed that when they are telling a story they change the way they tell the story according to who it is conveyed. Additionally they wanted feedback for when they found the cards, sometimes forgetting that they were meant to place the cards on the coloured sheets. The idea of finding the card became more important than the learning aspect. Their intention here is was not to learn, but to play. However, they were able to put this learning into perspective later, when they were able to retrace their steps and relate their findings to the story told previously. Furthermore, their decisions of where to place the cards were determined by where the previous one was placed, in most cases. Without being entirely aware, the children worked in collaborative game play and actually achieved the goal together. The idea of unfamiliarity came into play here, as they were both in an
environment that wasn’t so familiar and it was the first time in playing such a
game in this environment.

11.4 Step To The Sound

This element brought together the idea of problem solving and connecting
things through both sound and visual output. Through their creative skills, the
children were able to deploy this idea of connecting one thing to another, and
then listening or watching an outcome. I wanted to encapsulate these ideas in
an object mat.

The idea was that there was a floor space for them to navigate in, with
9 spots representing 9 different objects. Some of these objects corresponded
to the video clip that was projected on the wall. They would then have to step
on two items that corresponded to what they saw on the projection. Once they
stepped on the correct two spots, one after another, the movie clip would
automatically change. The movie clip was from the country in which the
objects related to, helping facilitate a learning environment for the child. I also
placed a rectangular sheet of plexi glass just below the projected screen so
that they would have the feeling of being in the movie.
11.4.1 Analysis

The children were able to form links and make sense of the different elements involved, when watching the video and listening to feedback of sound. The movie clip would show the function of the object, making it was quite straightforward for the children to find the object on the mat in front of them. On the contrary if was difficult for the children to form a link between the object and the place, which it was from or where it was used. The link would only be formed if they were aware of the context, which expanded beyond just the object. The prototype was tested in their preschool, under controlled conditions. If however this setting was moved to a museum environment, being informal in nature and without the children receiving instructions, it could be said that the first thing they would do is jump around on the different spots. This would happen in a manner that wasn’t necessarily coordinated and touched upon the tangibility of an object. This haptic manner is something that I had witnessed from the previous trip to the museum. The children didn’t necessarily make sense of what was happening when they saw a button or a different surface, and were compelled to touch and feel straight away. In summary, the element of tangibility and connecting things was important here and something, which contributed to the final design.

If we were to analyse these findings overall, I was able to establish a direct link between the explorative workshops and the final prototypes, The step to the sound workshop was a result of the fact that children were interested in putting their problem solving skills into practice during their trip to the museum. The digital jigsaw was the result of their sketching methods as a response to trying to bring together the familiar and unfamiliar world when I showed them the historical artefacts and during the cultural probe exercise. Finally the treasure hunt was a response to the actual visit to the museum from when the children got involved in building their own museums. Although there were some distinct reasons for why I decided to test the
prototypes that I did, the reason for why I chose the treasure hunt needs to be looked at a little further. We are aware that the treasure hunt design concept fits the themes of navigation, play, story telling and problem solving. In essence this brings together all the elements, which I have identified in my writing. In having closely looked at all three prototypes, it is also apparent that navigation is a strong theme in the treasure hunt, and when comparing the treasure hunt to step to the sound and the visual jigsaw, the navigation is utilised in the bigger setting. It makes use of the location in which the children play. Their curiosity is met and their sense of imagination is tested. Navigation became a strong theme through both the authorship role that the children undertook at the museum and when they built their own museums. When they were able to decide on how they would like their museums to look they aimed to utilise the space they had and have as much fun through play. The idea of navigating through space with them moving towards a final goal was envisioned. This movement was able to bring together all their senses through the idea of receiving feedback. For instance touching something had the result of something else changing colour. Moreover, the experiential element was combined with the fact that they became the authors when making their model museums. The cardboard museums became a representation on how they would like to navigate in real space. These fundamental ideas have contributed to the final concept through an overarching theme of navigation, which is apparent. However, the navigation developed meaning when the children were able to experience feedback as they moved from one place to another and when they used all senses and became part of the story, through using their whole bodies. Moreover, the fact that they combined the unfamiliar objects with their more familiar world, unveiled their curiosity and this curiosity was tested in an open space, which wasn’t restricted to a sound mat or jigsaw puzzle.
12

The Final Design Concept

12.1 How I intend to Validate My Final Concept

With implementing my final concept I have tried to achieve an explorative and playful environment for pre school children, with the intention of them learning about the educational artefacts that can be viewed in a museum setting. This was done through developing and testing the prototype, at the Varldkulturmuseet with a group of children from the International Pre School. The conceptual workshop was used as a foundation to help develop the final prototype, with the intention of improving both the material and dialogue used. I have also shown how this concept works through validating it using theoretical, analytical and empirical grounding.

12.2 Description Of Final Concept (based on phase 2 user test)

My final concept is the “Treasure (object) hunt”. This concept is based on the themes of navigation, play and learning, and is the output from the exploratory workshops, which were held. Play was a re-occurring theme which came about when I observed the children at the museum and when they
participated in different creative exercises. Moreover, the children tried to connect their worlds with the more unfamiliar world. This idea of trying to connect one thing to another and imagining a causal relationship, supported the idea of problem solving. Additionally, Storytelling, is an element which surrounds their world and as evidenced from previous workshops they were compelled to “tell a story” and also communicated their sketches through a story narrative.

Moreover, the concept is related to the aspect of learning in a museum setting. The idea is to involve preschool children in a learning environment, by using “play” as a focus. The intention is that children are embedded in an exploratory storytelling environment and they learn about educational objects as a result of this. The concept arises from the fact that museums keep many artefacts with years of culture and history, but behind glass boxes. However young children are more likely to have fun and therefore learn if they are able to use all their senses and interact with the objects. This concept allows the play environment to foster, and for the children to get close enough to the objects to be able to contextualise them and learn.

The concept involves children situating themselves in the exhibition. They are then brought into a storytelling environment by a teacher or staff member from the museum and told a story, which is narrated in the context of some objects that are in glass boxes. For instance the narrative of the story might unfold as follows;

“This story is about a little girl called Irene who is lost in the woods in South Africa and can’t find her house. She sees a lady playing the tambourine and asks if she knows where her house is but she says no. The lady can see that Irene is tired so she gives her a bottle of water and she tells her to take the boat to the island close by. Can you help Irene? Collect all the cards so that she can find her way home. Find the tambourine, water bottle and the boat”

At this stage the children aren’t told the full story, which allows them to build curiosity and enthusiasm. The intention is for them to then look for objects that are mentioned in the story and retrieve the cards (stencils) related to these objects (which would lie next to the objects). They then need to find all the cards in the exhibition to hear the end of the story. Once they find a card they bring it back to a specific station, where small boxes are placed, in a line. They then have to insert the right card in the right box, depending on when that object appears in the story. If the children place a card in the wrong box they don’t receive any feedback, which indicates that there is something wrong. However if they place the right card in the right box they hear a sound related to the object. The sound is triggered when a card is placed in the box, and pushed down, hitting a button at the bottom. The physical structure of the...
card and the specific placement of the buttons makes it possible to trigger sound at specific points. When the button is pressed it also triggers a second output where an LED blinks. Once all cards are found, and placed in the right boxes the children are able to hear the end of the story. This is made possible through the conditions that exist in the programming of the arduino and the MP3 shield.

![Image](image.jpg)

**Fig 25: animation & sound boxes**  **Fig 26: Stencils representing objects**

### 12.3 Theoretical Grounding For Designing The Concept

The concept can be theoretically grounded through the idea of play, exploration and storytelling. These elements are seen over and over again, during a child’s preschool years and I aim to bring these aspects out in an informal museum environment.

Previous theoretical knowledge has criticised the idea about framing a relationship with the audience in a museum setting, and the museum setting to not be for just gaining an experience (Hopper - Greenhill, 2001). My design concept provides an experience for children off course but at the same time the children are able to conceptualise their ideas and learn in an environment, with the museum staff, through the storytelling. Anway and Mayer also point out that learning is not a primary concept for a child and is a bonus added to a fun experience. (McRainey & Russick, 2010) Therefore, in using this design concept the children enter an environment whereby they aren’t standing in front of glass boxes and listening to audio, with an adult leading them through the exhibition. However instead they are open to explore and have fun, with no intention of learning, however they do learn along the way. As a result children can become engaged, cognitively, physically and emotionally. (Czikzentmihalyi & Hermanson, 1995) Cognitively in the sense that at their pre operational stage, they are able to address symbolic activity, (Piaget, 1969) whereby as J.Deloache describes they are able to retrieve information of a symbol to ascertain what it represents. (Deloache & Smith, 1999) As they enter the unfamiliar world in a museum setting, with artefacts they might not have seen before, the storytelling element allows them to conceptualise meaning. Moreover, children become physically engaged as they are able to...
run around and explore the environment in which they are. Additionally, the emotional engagement comes in from when they can relate to the type of play. In this case they are interacting with objects and are introduced to object play. Once they are then given the chance to play, the collections become a starting point for exploring and learning and they are more interested in learning - what does this object do? What is this used for? (McRainey & Russick, 2010). Therefore this design concept looks at creating a learning environment, through meeting the needs of children of fun and play.

12.4 User Testing

12.4.1 User Test Of The Prototype (Phase 1)

I conducted two user tests with children between 4 and 6 from the international pre school. This was a different set of children from the ones I had been working with at the workshops as I thought it was important to try the experience with a new set of kids who didn’t have any knowledge or prior workshops.

I conducted the user test at the World Culture museum in an exhibition room with artefacts behind glass boxes for people to view. The formulation of the user test was that the children were told part of a story, and six cards, were reflective of 6 objects in the exhibition which were in turn embedded in the story. These cards were placed discreetly, as close as possible to the actual objects. The purpose of the treasure hunt was for the children to find the 6 cards and once they found them all they would hear the end of the story through a set of headphones. Once the children found the cards they would bring them back to a station at the exhibition, where I had placed 6 analogue GIF boxes. They then placed the card in each box to see it animate, using littlebits. Littlebits are electronic modules that snap together with magnets. These bits were connected with 6 modules; the power, inverter (does the opposite of what you tell it), pulse (you can adjust the control for the speed of the light), wire and two LED’s. The basic function worked around two blinking LED’s, which blinked in turn.

![Fig 27: littlebits user prototype](image1) ![Fig 28: littlebit pieces](image2) ![Fig 29: littlebits joined with magnets](image3)
Some aspects of the user test were simulated due to the lack of time in preprogramming sound and light elements. In this case, I used the wizard of oz technique and placed a make believe button (soft cloth wrapped in foil) beside each GIF box. I then asked one child to press the first button next to the first box. I matched the child’s action, by playing a sound related to the first object, which was a tambourine. Once they heard the sound they were able to recall back to the story that they had previously heard about Irene lost in the woods. They all then ran to find the woman holding a tambourine. Initially, as they were in an unfamiliar environment they tended to follow each other. However, once they had found the first card and brought it back, to see the object animate, they were excited to go and find the next card. If a card was placed in a wrong box, I simulated a sound, indicating that it was incorrectly placed.

Children generally reacted in two different ways if the card that they placed in the box wasn’t correct. The first was to move to the next box and try and put the card in there and the second was to press the buttons to try and listen what the sound was.

The purpose of this user test was to create a learning environment combined with the element of play. The storytelling method allows the children to maintain the curiosity to want to know more and find out if and how Irene finds her way home. Furthermore, from reading out the story first they are able to develop an understanding of the environment and then relate the objects to that environment. They are also able to trigger their memory from listening to sounds, which helps in maintaining the learning and fills the gaps.

I conducted two user tests with two groups of nine children. The difference in their level of understanding was established from the difference in my storytelling technique. I told the story in person, which I think was really important in helping create the enthusiasm. However, it was apparent that when I conveyed the story to the first group, I read it out like a script and as a result the children didn’t necessarily pick up on the sounds and which objects they might be related to. With the second group, I was able to emphasise on the objects and the style of the narrative changed here, and I explained the objects in more detail. As a response to this the children were very quick to relate the sound to the objects.

12.4.1.1 Validation Of Design Results (Phase 1)

My final concept intends to achieve a learning environment in the museum setting of the world’s culture museum, through a playful environment, conceptualised through a story narrative. In undertaking the user test a playful environment was created, using tangible interaction. The children were able to run around and explore the setting,
when looking for the stencils. A collaborative environment was created as the children moved around in a group, with them all maintaining their focus on finding the same stencil. This collaborative environment was a result of the children having the choice and control to formulate both a meaningful and fun experience. (Kay, 1998) The prototype supported this idea because the children were able to attach meaning to the story narrative through listening to the sounds that related to the story and then finding the cards that represented this narrative as well. They were able to attach themselves to the idea of learning in their mind whilst they actively participated in a “hands on” experience. Richard Gregory emphasises the role of hands on in turning minds on (Gregory, 1992), which was something that was seen when conducting the user test and looking at the level of engagement that was achieved. The idea of finding a stencil, and bringing it back to a specific spot and placing this in a box to then receive feedback was the engaging point. However, from observing this user test it was searching for the paper stencil that became more important than the image of the object.

Moreover, children at pre school age can only concentrate on doing one thing at a time. In this case they aren’t thinking about what just happened or what will happen in the future. (Flavell and Miller, 2002). Therefore, if the intention here is that children will learn about the artefacts through problem solving, we need to keep in mind that when they are involved in the treasure hunt, they are mainly thinking about the treasure hunt itself and finding the hidden cards. It is also worth questioning if they remember the story narrative that was just told. Nevertheless, it is important to remember that children at preschool age are interested in and do understand the idea of sequencing, causation and organising abstract form (Green & Hogan, 2005). So therefore, for them to find the more abstract cards to fit into a predefined storyline still helps in creating a unique environment. From observing the user test however, it became apparent that some children wouldn’t understand the link between the sound buttons, cards and boxes, if they weren’t directed. There were too many conditions that determined whether the feedback was attained. Some of the children were confused with the order in which they should be interacting with the prototype and others were just happy to use trial and error in terms of gaining feedback, by placing the cards in boxes until they saw an animation. For them it seemed more logical to do this than to press a button to hear a sound, which would be a clue to which stencil to place in which box.
12.4.2 User Test Of Prototype (Phase 2)

The second phase of the user test took place with a different group of children from The International Preschool. I undertook the test at the Word Culture museum, using the same setting as the first. However, this second phase saw a different set of props, determining a high fidelity prototype and an improved dialogue with the children. I used the same approach for the test in the way that the children were told part of a story, where they had to find the stencils related to the objects in the story, where they would hear the end of the story, once all the stencils were in the correct boxes.

With the second user test the idea was to move the focus from the stencil, which was a piece of plastic, to the actual object. The focus was maintained in the way that the children didn’t have to encode which object stencils they would firstly have to find, to then try and understand the order in which these would have to be placed in the boxes. They were told about the objects which they would have to look for, when the story was told. The dialogue was also changed in the way that the children were told “Irene is lost and needs help from you”. The intention with this approach was to not only change the original focus, but also open up further questions, like “what is this used for?” “Why is it used this way?” and to create links with the context in which the objects are used.

The use of props was also improved in the way that I decided to remove the sound buttons, and instead added sound as a feedback from when the children placed the stencils in the boxes. The prototype was therefore constructed in the way that when the children were told the story they would return the stencils (representing the object) to the boxes in the order in which the object was mentioned in the story. They would then hear feedback, in two ways, the sound and animation of the object. However, if they didn’t receive any feedback this meant that the wrong card was in the wrong box and they would then try another one. I also made use of high fi material, whereby the boxes were made from MDF board and the stencils were cut out using plexi glass. An MP3 player and LED, controlled by an arduino board, controlled the sound and light. Pressing a button, placed in each box, triggered both sound and light. The physical affordances of the stencils and the positioning of each button, enabled the correct stencil to hit the right button, and therefore the corresponding sound was heard and light triggered.
12.4.2.1 Validation Of Design Results (phase 2)

12.4.2.1 (a) Evaluating The Children’s Experience

During the treasure hunt the children were very responsive to their surroundings. They had established a connection to the story, through the dialogue in the beginning and this was seen during the experiment where they took the time to look at the objects behind the glass as well as collecting the individual stencils. The user experience became more about searching for the object compared to searching for only the plastic stencil. Most children worked collaboratively, splitting up into a few groups. The children were quite fast to understand the order in which the stencils should be placed in the boxes. Here it was apparent that they were thinking about the story as they undertook the treasure hunt. However, the feedback was still a vital part of the user experience and once the children saw the animation and heard the sound related to the object, they were able to move onto searching for the next object. The children were therefore able to make a clear connection, through the tangible interactivity that occurred. A causal effect existed, whereby, if you put a stencil into the box, something happens and if the condition was not fulfilled, then there is something wrong, so they would correct this through adding the stencil to another box. This would continue until they simultaneously heard a sound and saw an image. In receiving this feedback they had another opportunity to become engaged into the story. The learning became apparent when I spoke to the children about their experience afterwards. They remembered how the story took form and could also make links as to why the girl in the story needed the boat for instance.

Additionally the museum curators were positive that this technique with using a tangible interface, and receiving feedback is something that museum exhibitions need. The curator also stressed the importance of establishing the setting of the treasure hunt and how this was as important as the physical product when achieving the children’s experience. If analysing this point we can see that a number of different aspects come into play here, the interaction design, the storytelling and learning. These elements need to be looked at separately and careful balance needs to be maintained once combined, for an effective treasure hunt to be delivered.

The feedback from the curator also highlighted the importance of getting the message across in the story, and how the experience might be improved through providing visual images of the objects, before the children look for them physically. This could be done through storytelling in the form of an animated film as opposed to reading out a script.

12.4.2.1 (b) Comparing The Treasure hunt To A Benchmark
1. Story time At Preschool

When we compare the treasure hunt to a story time in school, the differences are apparent. Firstly in the sense that story time in school sees the children sitting more passively, listening to the teacher read a story from a book. With the treasure hunt the children were able to take the responsibility in becoming actively involved in the creation of a story as they were helping Irene find her way home. Even though the story was pre defined as that in a book, during story time, the collaborative involvement to achieve a final goal, meant that the children and not the teachers became the authors.

Secondly, during story time the teacher asks questions to ensure that the children have understood. This understanding comes about from listening to the teacher and watching the illustrations in the book and not participating actively as such. During story time there is no tangible interaction that takes place, and this has the effect of some children becoming distracted and sitting at the back of the room, occupying themselves with other things. However children receive feedback, both during story time, when the teacher answers questions and throughout the treasure hunt in the form of light and sound. The difference with the treasure hunt being that tangible interaction triggers feedback and not direct verbal communication with the teacher. The tangible interaction further determines that more children are engaged during the treasure hunt, when compared to story time, as they become involved in playing. They become immersed in the story and can help determine the outcome of the story through contributing content. Here they are empowered to make choices and have the control of what they want to do and for how long they will do it.

2. Standard Museum Tour

A standard museum tour, is normally led by a museum curator, whereby he/she leads a group through an exhibition, and talks about the objects behind the glass boxes. The main form of interaction here is that the one leading the group talks through a microphone and everyone listens through a set of headphones. The exhibitions that are directed towards children become a little bit more intimate in the way that the children will follow the curator, who will try and immerse them into the surroundings through a form of role play. A specific exhibition, which takes place at the World Culture Museum, is that of the “the earthlings”. Here the children learn about earth and how the humans live. During a tour such as this the interaction becomes or should become more personal. However, in some cases this isn’t the case because even though a role-play is enacted to help the children get into character,
there is a routine that surrounds the role-play. The guide makes a stop at specific points and in most cases there isn’t time to address specific questions that the children might have. Moreover, when the children pass through the different stations at the museum they want to be able to both feel and touch something, and the interest for the object is lost quickly if they can’t interact with their senses. From my observations I was able to see that the tangible interactivity played an important part in the user experience at the museum. However, this experience isn’t fully utilised during specific educational tours, due to time restrictions.

On the other hand the treasure hunt enhances the user experience in the way that the children are able to again have the control and authorship of “time” and control of the story. There is no specific routine that has to be followed, and they become responsible for their own learning. They are able to learn by putting things into practice, through tangible interaction, having the control to when the end of the story is heard. However, a critical analysis of the treasure hunt would determine that although the children act as recipients of new meaningful information that gives them the authorship and control, they are playing in an already scripted environment. They are taking the control to find the hidden stencils, but adults have hid these and an adult has predefined the story narrative. This has the effect of taking the control away from the child in a way. Nevertheless the story narrative is part of a bigger design process that exists.

Conclusion
In conclusion, from my workshop findings, theoretical evidence and empirical evidence from both user test phases it can be seen that there is room for play in a museum setting and yes we can develop the environment in a museum to reflect playfulness and exploration, and create a learning environment at the same time. To confirm the research question, yes we can engage children by making objects and historical collections interesting, through story telling and play forms such as treasure hunts. As we know children like to have a “hands on” experience. They like to be absorbed into an environment and in doing this they use all their senses. Previous workshops have shown how this is apparent in their way of thinking and when “doing”. Children liked to use their hands and feet when testing using prototypes, such as step to the sound, and when building their own museums, they talked about being “in the objects”. Now this represents how they like to be engaged more physically. It is apparent that they look for a fun experience, which involves play, so why not give them that. As well as play there are other elements which are important in defining a child’s relationship to their environment, and therefore helping us as designers and researchers to understand the their actions and maintain the level of learning that we are trying to develop. Children create “meaning” based on representations of their world. This meaning is created from the knowledge that they have gained from previous experiences. We have to begin by understanding that the meaning we as adults create is different from that of children. As Druin mentions we can’t forget that they are children and for us not to see them as little humans. We often make assumptions about learning theories for children (Piaget 1986) and on the contrary children have trouble verbalising their thoughts. Therefore there seems to be a clash of differences. We can’t make these assumptions about children and need to step into their world as well as trying to bring them into our world.

As a result of these differences that exist and to create the learning experience that is required, it is apparent that we should bring children into the design process. As Druin recognises there are four ways in which we can bring children into the design process to ensure that we make effective use of technologies. My design process concentrated on bringing children in as Informants. They contributed to the design process in terms of testing, brainstorming ideas and focus groups. I was able to combine their ideas with my skills as a designer and formulate solutions, which were both interesting for me to research and responded to their inquiries. Once we are able to therefore understand their likes and dislikes we can begin to form a picture of how they create meaning and what is important to them. Through the initial exploratory workshops I gained an understanding about their familiar environment as well as their unfamiliar environment, which is new and creates curiosity. It became apparent that for children to unravel this unfamiliar environment they incorporated their ideas into their more familiar settings.
This was seen through their sketches and observations. If we therefore apply this to the museum learning environment, we can embrace the area which is unfamiliar to children, and try and combine it with what is familiar, to help in developing a learning environment. This then leads to the final design concept, whereby the artefacts (which some children haven’t seen before) are brought into the game play of a treasure hunt. They are then absorbed into what they know, in a playful way, and through doing this they learn about the objects. They can use all their senses, where they run around, touch problem and see the feedback from doing something. At the same time as learning isn’t a primary concept for children, the bonus is achieved through adding this as a fun experience (McRainey & Russick, 2010). Moreover in understanding our users, we are able to provide a learning environment, without having to make “burthen on them” (John Locke, 1693). They are in control and have no obligation to do something. They become the authors of their environment.

Moreover we are able to meet their learning environment with narrative that they are familiar with. The research undertaken through workshops at the museum and the cultural probe exercises saw the children explaining their thoughts through telling a story. Children are surrounded by a story telling environment from an early age, at home and at school. Storytelling is imbedded in many ways in the museum setting and seems to work in translating knowledge through ubiquitous computing and a tangible user interface, with the learning not necessarily situated to one spot. The learning experience is constantly taking place and one object is linked to the next and all objects are encapsulated in a greater narrative. Through this narrative the children are able to make connections and see the results of something happening once triggered. Their curiosity is then built throughout the experience, while they wait to hear the end of the story. The fact that they like to connect things and see patterns can be seen through the previous workshops where they all played a part in building the museums and in their sketches.

We have therefore established that for us to create a learning environment for children we are required to engage all their senses through the tangible interaction that takes place in the storytelling environment.

When undertaking the design research phase it is important to understand the challenge of working with children as participants. They conceptualise the world in a different way from adults and their likes and dislikes are not the same as ours. (Bergman, 1977). They are also not able to verbalise concerns the same way as we do. From the workshops it was apparent that when a closed question was asked, such as “why did you choose to do that”? The answer would mainly be “because i like it”. This doesn’t give much more information to what I already knew, but at the same
time it was important to see how this element could be brought into the design process positively.

A difference in communication is also evidenced when participation doesn't take place. For instance if an adult asks a child to do a task and he/she becomes bored, they may just walk away, distract another child or just sit there. They are “acting out” (Druin, 1999). The lack of participation gave rise to alternative ideas and iterations, where I was able to question the element of skill in participation. Children's participation can be critically assessed to remind us again that children are tied by a completely different set of culture and norms and bringing them in as “Users” in a design process might pose certain challenges. So the question arises, as to what degree do we want children to be the participants in the design process and to what degree should they be consumers and “reactive”. Will it be beneficial for the children to be part of making a creative story in this design concept, as opposed to be handed out a pre written script? It is however difficult for us to generalize these answers because a child’s schema extends beyond the actions based on psychological development, alone. Children develop their personalities in many other ways, with socio cultural factors being one. Lev Vygotsky looks at how learning occurs amongst children when they interact with others in their environment. (Vygotsky, 1978)

Based on this theory, it is evident that learning fosters in social environments such as museums and this learning needs to be filtered in a suitable space and setting, embracing the notions which can help create meaning for children. Moreover, my design concept allows room for this social setting to take place, in a physical storytelling environment. The children are able to collaborate in an environment, which allows them to play, interact and learn together. They are also able to extend their participatory skills and create meaning, through taking authorship and having control of the decisions that they make. The collaborative goal is to be able to receive feedback, and this is encouraged through ownership when an active part is played in collecting the cards, enabling the end of the story.

In Summary we can see that the design processes allowed for collaboration between the children and design activities made room for creativity through tangibility, with the children making the choices. The elements of the participatory design methodology were used in the implementation of the final design, using storytelling and tangible user interfaces to help promote a collaborative learning environment, where the children became engaged.

Moreover, my final design will have an implication in both the Interaction design discipline and amongst curators in the museum community. The research that I have undertaken allows the Participatory Design community to understand the implications of designing with children in both a Museum and Pre School environment. The insight into this will lead to scope for the development of more “hands on” learning environments, and will enable Interaction Designers to explore this area and help design installations incorporating tangible interaction and provide an environment where learning can take place. The Interaction Design community can also learn how best to address these cultural communities and this constantly changing
environment. The Interaction Design community will be able to develop a platform to help shift forward, the design for museums, especially in those that lack the interactive learning design element. The design community, pre school and museum can all gain an understanding of how simple interactive artifacts can be combined with storytelling and play forms such as treasure hunts to help engage children. The museum will be able to learn that the tangible interaction and storytelling helps in promoting a collaborative fun environment, replacing traditional museum tours. The pre school will learn how the tangible interactive environment brings about an additional layer to storytelling, helping establish control and authorship, amongst children, thus increasing engagement.

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APPENDIX

Appendix 1 - Daily Schedule: (a typical day)

08:00: Kids arrive and have breakfast

9:00-10:00: Circle time - the children dance and sing together with the teacher

10:30: Activity time (based on monthly theme) - This could be indoors and/or outdoors. Experiential learning is encouraged here. This time also includes Letterland, Second Step, Mathematics, Science, Cookery, Arts and Crafts, Music and Movement

11:30/12.00: Story time - The teacher reads out a story for the kids

12:15-13:15: Lunchtime

13:15-13:30: Rest time

13:30-14:00: Quiet free play (puzzles, games etc.) - This is until all group is rested

14:00: Activity time (based on monthly theme) - This could be indoors and/or outdoors. These activities include fine and gross motor skill development

17.00 - 17.30: Preschool closes
Appendix 2 - 4 programmes, under which the school operates:

- Letterland - child-friendly, multimodal system for teaching children to read, write and spell.
- Second Step - teaches social and emotional skills for violence prevention
- Music and movement - where they make and play instruments with the children as well as dancing
- Green Flag - looks at working towards an ecological school

Appendix 3: Results from the Treasure hunt at the museum

- The children were initially guided through the exhibition The first thing they saw was a shape changing mirror, and were very amused by this. This was an activity, which was based on an element of distraction and the reasoning behind this was that all humans come in different shapes and sizes. Their exploration skills came into light when they entered an open space, following on from a tunnel experience.

- At a counter, which had hidden drawers and sound, I had previously added a small sign with a pictogram of a telephone. At this point they thought that they had to listen to something and speak about something at the same time. As they didn’t quite understand the idea of the telephone icon, they were compelled to “tell a story”

- Images of hieroglyphics on a wall, saw the children looking for some sort out output from pressing their hands against the signs. Some of the children tried to tell a story and thought that the wall would open if they pressed on the signs on the wall

- At the nature station they wanted to be able to touch the fish and flowers that were under glass. A pictogram with an image of a scroll was interpreted as treasure, and the idea of unveiling something under the glass.

- There was an area where they could play and become submerged in a pile of cushions. They enjoyed spending most of their time there, where they were able to be free.

- Coloured material on the floor became sensors for them and they thought that they had to unravel a story, whereby if they stepped on all three there would be some sort of output.
- At the space counter, there was a visual of the solar system, where they were able to listen to a narrative through headphones. Some aimlessly pressed the buttons, even if not listening through the headphones.

- There was a space where music was triggered as individuals closed in to the area. Once the children became aware that the music was based on movement they became very active, jumping up and down.

**Appendix 4: Results from the cultural probes – 1st experiment**

1. What is important to you?

- Family and sense of security
- Communication and interaction between space and environment
- Individual interests revealed through their differences in culture
- The outdoors as this is something which isn’t as familiar as the indoors

2. Make a gadget for the martians in Mars, for them to see how the earthlings live

This was quite abstract and not representative of anything in their mind. It was difficult for them to establish an understanding of something so abstract. The word had to be clarified through examples and most of them drew the examples that were mentioned. As they were in this unfamiliar realm they tried to add other aspects to their drawings that were more familiar, such as family members, hearts and flowers. However on the contrary one child was able to draw a computer that would be on Mars so that they could see what the earthlings would do. He was able to relate to this question because of his interest in planets and the solar system.

3. Draw a dream planet. Are there trees, water and cars?

Most incorporated their homes and family in their drawings too. Some included nature with things such as flowers, animals and rainbows. One girl misinterpreted “dream planet” and drew herself in her bed.

Another girl made a connection with nature and showed how a snake helped a flower grow.

4. Draw you and your family if you were aliens.

- They were able to draw people in perspective, i.e father being the tallest.
- Many represented a “play” element in their sketches
5. Make a spaceship

Many of the children were able to combine the unfamiliar with the familiar and bring in aspects of their own interests into the picture. Some of the spaceships which were drawn - as a fish, house and butterfly

6. Draw nature, fear, music and signs.

Nature was represented as outdoor “play” for some through slides and swings and for others it was representative of the nature itself in the form of leaves, trees and flowers.
Fear was individual and varied based on cultural boundaries at home. Some showed fear from socially constructed ideas. For instance fear arose from the fact that they weren’t meant to go upstairs or when they were on their own.
Music was mainly represented through a music player, however one girl used the idea of using a more expressive form, of the whole body, to listen to the music. The music was therefore heard as a response to stepping on a dance mat.
Signs were mostly represented through what they had recently seen and could relate to. In this case it was the “no entry” sign that I had placed in the museum. Once they had been told that this was a no entry sign they could then relate to it and represent it in their drawings. This sign was then used in some of their environments, with which they were familiar with. For instance one of the girls that had previously talked about fear coming from the fact that she wasn’t allowed to go upstairs, also drew a sign to say that she “can’t go upstairs”. Again they were mixing the familiar and unfamiliar world. Furthermore they weren’t able to understand that signs were related to language as this isn’t in their language when communicating.

Appendix 5: Results from the cultural probes – 2nd experiment

Brainstorming session: discussion about museum visit and what is important

The element of space - and the need for a big space
Awareness of differences in humans
Understanding of different housing in different places and different ways of living
Understanding of the basic survival techniques
A statement from one of the children:

“It is important for the humans to have fun so that they can relax”
Appendix 6: Results from showing the objects & sketching

The kids had seen most of these objects for the first time. They were very intrigued by them and were able to imagine what they could be used for. The motivation to want to learn was there because they were able to touch, feel and play with the objects and learning therefore occurred through distraction. Some of them were able to bring these objects into their stories that they drew in an interesting way. In one example for instance a girl drew a storm and herself and then a big bell forming an arch over her, and the idea was to be able to control the storm from hitting the bell. The function of the bell was the same as a musical instrument but the context was different. She was able to establish the causal effect of hitting the bell.

It was interesting to see their individual personalities through the shapes, sizes and colours of their sketches of the boat. They distorted the images through adding elements that were familiar to them. Most drew the boat to fulfil the function of a boat, being out on sea and going from one place to another. Some of the children again drew things in their familiar world such as a house and a flower and added the musical instruments to these drawings. An example was where a flower head represented a musical instrument and the stalk was similar to the stalk of a flower.

Appendix 7: Results from Building the museum

They museums concentrated on the element of play. The sponge, cardboard, lego, etc were used to represent elements of fun. The characteristics of the museums included:
- The element of play and fun through jumping, sliding, spinning and playing a game
- Competition, which allowed the person to win through gaining points
- Navigating from one place to another and from going over and under things
- Visual - seeing the world from the outside and looking in to see something else
- Creating connections where one thing leads to something else happening, through combining objects or changing colour
- Conceptualising - building a mountain
Appendix 8: Final Prototype
Appendix 9: Sketches – Visual Jigsaw & Storymat Prototypes
Appendix 10: User Test 1: Low Fi Prototype