Designing with Children:
Reflections on Effective Involvement of Children in the Interaction Design Process

by

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Abstract

This thesis contributes to the discussion around the practice of co-design with children by providing support for reflections to practitioners. The framework that derived from this research aims to increase the awareness on the implications the different aspects involved on co-design session have on its outcome. Researchers with little experience in managing co-design sessions can benefit from it when deciding on their co-design strategies.

This reflective support is the result of research towards understanding the co-design practice as a complex and unique activity. The process of building this understanding started with the analysis of the literature in the field and direct experience in design projects resulted in a list of lessons learnt and a review of techniques applied in the field. An initial structure of co-design sessions with children including all the elements implied in the practice was then developed and used as a prop for discussion with novice practitioners in field studies. The analysis of practitioners' perspectives validated previous knowledge of the challenges of co-design sessions and highlighted the potential of a framework to assist them. The framework presented in this thesis follows a *Why-Who-Where-When-What-How* structure and it is conceived as an aid for practitioners to reflect on the implications that each element has on the experience of the co-design session. In this way it is thought of as a dynamic and flexible reference that can be adapted by design researchers when planning and coordinating co-design sessions to suit different design situations. The use of this tool in the Interaction Design and Children research community would provide an ongoing validation of the effectiveness of the framework and its continuous improvement.

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Acknowledgments

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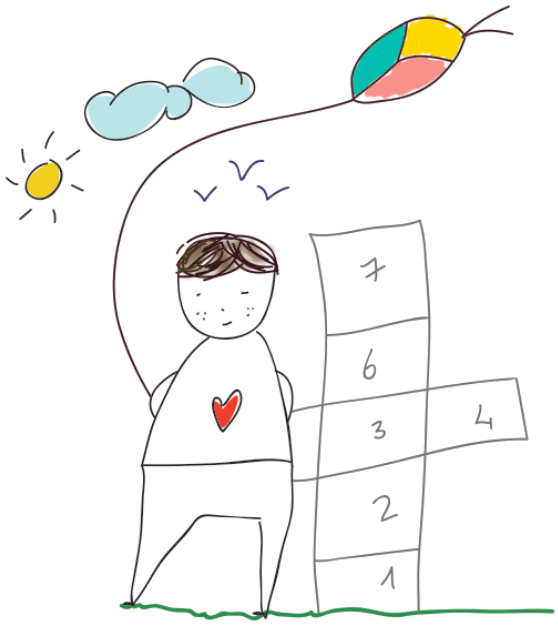
“Childhood is measured out by sounds and smells and sights,
before the dark hour of reason grows"

John Betjeman – Summoned by Bells (1960)



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1 CHAPTER ONE: INTRODUCTION

This thesis contributes to the discussion around the practice of co-design with children by providing support for reflections to practitioners. The research presented in this thesis followed and exploratory approach on the practice of design technologies for children and resulted in a framework to use in co-design sessions.

This chapter provides an overview of the research of this thesis: its motivation (Section 1.1); an overview of the research context from Human factors to Co-design with children (Section 1.2); the approach adopted for this thesis to understand the design practice (Section 1.3); the research aims and objectives (Section 1.4); a disambiguation of the terms most used in the thesis (Section 1.5); an overview of the methodology adopted throughout the research (Section 1.6); and finally an overview of the structure of the thesis and its chapters (Section 1.7).

1.1 Research Motivation

Having an Interaction Design background I have always been interested in design and creative processes, and in how valuable ideas make their way to a product. My interest focuses particularly on 'normal' situations – i.e. where no extraordinary talented people or creative gurus are involved in the process. In this respect, User Centred Design, and more specifically Interaction Design, have a huge variety of ways and techniques to trigger creativity and build up ideas to create products that would ideally be useful and usable. Exploring contexts, involving users, and envisioning scenarios are all considered valid practices for the scope.

When I started to work in research projects with the Child Computer Interaction group my attention automatically shifted into how to transfer these concepts to the context of children's technology. In this research setting, there were more variables to be considered and more assumptions to be avoided than in adults' contexts. With these conditions, involving the children in the design process, as in co-design and participatory methods (Schuler and Namioka, 1993), seemed an appropriate approach. Taking part in different short-term (shorter than one year of duration) projects and several ad-hoc design sessions, I had the chance to explore different techniques in different design situations and reflect on what it implies to design technologies with children. Moreover, the involvement of school children in design

activities resulted in an increasing interest from schools to collaborate in design research projects, as teachers valued the motivation and creative stimuli that children get from participating in such activities. Additionally children's feedback collected at the end of each session confirmed their overall enthusiasm and enjoyment.

The analysis of a multitude of studies reported in the literature, together with my own experience in the field, created the basis for reflecting on the practice of design with children, its different applications and interpretations. These reflections led to the proposal of a framework that organises all the elements implied in co-design with children. The overarching goal is to facilitate appreciation and employment of the practice, especially for researchers who are not expert in this practice and want to embark on it.

1.2 Research Context: from Human Factors to User Experience

The research presented in this thesis follows the principles of User Centred Design (UCD), the approach to design that puts the needs of users at the centre of the design process (Norman and Draper, 1986). Human–Computer Interaction (HCI), Interaction Design and the practice of co-design are all based on this approach. To give an historical overview of its development, roots of HCI are to be found in Ergonomics and Human Factors research. Since the early decades of the 20th century, particular attention arose around human factors and around possible ways to enhance the performance of machines manoeuvred by humans by studying ergonomics and the human cognitive process. The interest was initially around airplanes and military machines during the Second World War, and then enlarged to mass production chains with the post-war economic boom (Meister, 1999). Research interests have since spread to a wider domain, looking at systems used in working contexts and how they could be modified to reduce the chances of mistakes when people used them. With the increasing use of computers, the 1980s saw the beginning of the discipline of Human–Computer Interaction: by looking at how humans interact with computers, HCI is primarily concerned with the design, evaluation, and implementation of interactive computing systems and relates at the same time to technical, physical, psychological and social aspects involved in the interaction (Winograd, 1997). With the application of computers expanding from work to personal contexts, the research focus of the discipline started to include

technological artefacts employed in everyday life activities – from work to leisure, from education to health. In the 1990s the term Interaction Design (ID) gained popularity: it included the theory, research and practice of designing interactions with all kind of technologies (Preece et al., 2002). ID is itself a multidisciplinary practice that involves a variety of components, from cognitive psychology to social science, from engineering to computer science and from architecture to arts, all of which play a significant role in understanding and developing interactions with technologies (details of the ID process are given in Chapter 2). From the focus on the interaction in real contexts, the research of the field has moved towards 'user experience', underlying the strong connection of the interaction with the situation of use and personal perceptions, considering the experience with the technology as a whole (Wright et al., 2006). Harper et al. (2008) stressed the importance of understanding the human values implied in the specific design in order to enhance the user experience the artefact can support. Not to be interpreted as the 'design of the experience of the user', User Experience design relates to designing tools and conditions for the users to get a possibly satisfying experience with the technology they use (Sharp et al., 2007). Moving the focus from the machine to the user also implied involving them in the design process at different stages, with an increasing tendency to actively engage them in the early stages of concept generation, a practice generically called co-design (Sanders and Simons, 2009).

While HCI expanded from work to everyday activities, the range of target user groups increased by addressing different abilities, cultures and ages. Thus, in the 1990s children started to attract increasing interest in commercial and educational contexts and became a specific user group to design for (Markopoulos and Bekker, 2003). If the initial focus for adults' technology was on productivity, for children's products it was on learning and later extended to entertainment. Consideration of Usability and User Experience is fundamental to achieve these goals, especially to avoid adults' assumptions on children's requirements (Bruckman and Bandlow, 2003; Markopoulos and Bekker, 2003) and HCI methods have subsequently been adapted to consider the specific needs of children users. Markopoulos and Bekker (2003) consider two main topics that are investigated for this adaptation: age-specific interactions and the involvement of children in the design process. The research

presented in this thesis belongs to this second topic, aiming at understanding relevant aspects to take into account when involving children in design.

1.3 Understanding Design Practices

As suggested by Stolterman (2008), research that aims to support the Interaction Design practice has to be based on a deep understanding of design as a complex human activity of inquiry and action. The research presented in this thesis adopts this perspective and explores possibilities to support the co-design practice with children by understanding the nature of the practice and its implications. It has been reported by Rogers (2004) that designers in their practice do not commonly use prescriptive models or theory, but rather, they do make use of a specific range of methods or tools they are familiar and skilled with. This finding is in line with Schön's (1983) theory of knowing-in-action, as a tacit knowledge of the practice mastered by designers that only becomes explicit when they are facing difficulties or unexpected situations. This occurrence provokes a shift to conscious reflection on what they are doing – what Schön calls reflection-in-action. It is not possible to know in advance what a design will end up being as there are many variables in play and the consequence of the actions are not always in control (Fallman, 2003). Therefore Schön talks about the need to prepare practitioners for the design process – rather than to guide them through it (Schön, 1983).

The concept of mastering a practice, as referred to in Schön (1983) is related to the concept of practitioner's expertise. The definition of novice or expert practitioner is liable to subjective interpretation. Dreyfus (1982) defined a model that describes five stages a novice practitioner goes through before becoming an expert, including advanced beginner, competent and proficient. Several applications of and discussions around this model (Benner, 1984; Eraut, 1994; ICON, 2003; Atherton, 2012) resulted in identifying useful variables that differentiate novices from experts, e.g. acquired knowledge and competence of a practice, standard of work, independence of judgement on what is appropriate to apply in which situation, autonomy of problem solving, and coping with complexity. In the context of this thesis I refer to novice practitioners as derived from Dreyfus' model as those who have not developed a tacit understanding of a situation that allows them to develop a strategy for action without the need of guidance. With this perspective, the framework presented in this thesis

supports the practitioners in the understanding of the situation and the decision process.

As experienced by Hornecker in her creation of a framework for tangible interaction, "*discussions with designers had made it clear that* [the framework] *should not provide 'guidelines' since the concepts are rather 'things to think about'. There is a risk of guidelines being followed somewhat mechanically, trying to tick boxes*" (Hornecker, 2010). The research of this thesis goes in this direction – it does not provide a theory or a prescriptive model on doing co-design with children: the aim of this research is to provide a framework that can be useful in concrete instances of the practice, as a support for reflection, especially for novice practitioners. This reflective support is the result of research towards understanding the co-design practice as a complex and unique activity (as defined in Stolterman (2008)). In this thesis, this understanding is drawn from the analysis of first hand and reported experiences of the co-design practice with children and contributes to the development and improvement of the practice.

1.4 Research aim and objectives

Nesset and Large (2004), in an extended review of projects that involved children, conclude that, although co-design techniques can often be expensive and time consuming, the advantages in terms of innovation and appropriateness of design can outweigh the negative factors. Therefore, "*the real issue would seem to be not whether involving children is good or bad but rather how to more effectively engage them in the design process"* (Scaife et al., 1997). Marti and Bannon (2009) started from this statement to raise awareness on the potential difficulties of UCD strategies and the need for a more nuanced approach to their practical implementation. More recently, Sluis-Thiescheffer et al. (2011) noted that the question moved from 'how to apply a design method' onto 'why apply a specific method', and they proposed a framework for supporting the choice of certain methods by relating the characteristics of children to the characteristics of design methods. Taking all these research directions into account, the scope of this thesis is to increase the awareness of all the elements involved in a co-design session that influence its output and therefore need consideration from researchers, especially novice practitioners.

Under these premises, this thesis' aim is to propose a deeper understanding of the practice of co-design with children and suggest critical factors to refer to when preparing for it. Therefore, the main research question posed in this research work is:

> RQ: How can researchers be enabled to run effective co-design sessions with children?

In order to answer this question, it has been broken down into smaller sub-questions that integrate and contribute to it.

> RQ1: How can the complexity of co-design practice with children be broken down?
>
> RQ2: What are the key elements and factors that influence the co-design session?
>
> RQ3: How could co-design sessions with children be formalised (modelled) to ease researchers' practice?

To respond to these questions, this thesis is addressing four different objectives.

1. To gain an in depth understanding of the practice of co-design with children. This objective is achieved through the review of the literature and research projects (the author's and others). The initial set of considerations about the practice and its open issues derived from this objective provide an initial answer to RQ1 and RQ2.

2. To investigate the perceptions and experience of novice practitioners of co-design sessions with children. This objective is addressed in *ad hoc* field studies and interviews with the researchers engaged in them. These studies and the related discussion provide the answer to RQ2 and part of RQ3.

3. To identify and specify critical factors that affect the practice of co-design with children. These factors emerge from the field studies with novice practitioners and complement the findings from literature and previous work towards RQ2.

4. To develop a framework of the critical factors of the practice of co-design with children that affect co-design sessions. Based on the critical elements

which emerged from the research, the framework provides references for planning and structuring co-design sessions with children. The framework is presented in Chapter 6 to answer RQ3 and the main research question RQ.

1.5 Defining Terminology

Terms like children, framework, methods, or tools, may have different interpretations in different contexts. Since these terms are going to be used frequently throughout this thesis the meaning they each have in this text is disambiguated here.

Children: generically refers to young persons not fully physically developed. This development also refers to their cognitive and social skills. Until 15 years old, children can be differentiated as infants, babies, toddlers, early years, and teenagers. In the context of this thesis, children are school age, between the ages of 6 and 14, with a focus on the core group between 7 and 11 years old, as specified in Chapter 2.

Framework: literally refers to a basic structure supporting an object – when this object is a system or a concept the framework is considered as the combination of the principles and theory underlying it. Rogers and Muller (2006) talked about the use of 'frameworks' in HCI as going from more prescriptive ones, which mainly comprise a set of steps or principles to follow, towards more explanatory frameworks, presenting concepts or dimensions to consider in designing experiences. The framework resulting from this research belongs in the explanatory end, as it defines the dimensions and related factors to consider in the co-design sessions with children.

Model: a simplified representation of a situation or of the important aspects of it. The model presented in Chapter 6 is a visual representation of the relevant elements involved in co-design sessions.

Methodology: can be considered as practice that arises from what is done in a given situation. A methodology in these terms is both the result of, and the process of, inquiry where neither theory nor practice takes precedence (Checkland, 1985). In this research work it mainly refers to the application of methods and techniques into context according to specific principles. Participatory Design can be considered a methodology when methods and techniques following its principles are applied in context.

Method: a structured and defined procedure towards an objective (Baskerville, 1991). Requiring a theoretical foundation, a method provides a collection of tools and techniques to apply in a specific context. The following quotation clarifies possible confusion on the different terms: "*how* [a method] *is put into practice will determine whether an observer could describe it as methodology or method. If a practitioner engages with a method and follows it, recipe-like, regardless of the situation then it remains method. If the method is not regarded as a formula but as 'guidelines to process', and the practitioner takes responsibility for learning from the process, it can become methodology*" (The Open University, 2010).

Technique: a specific manner to achieve a goal and concerned with the skills and the ability involved in the execution. In this thesis design techniques such as 'prototyping' or 'role-play' are referred to and these are shown to be able to be applied in different design methods.

Tool: is an instrument used to perform a task (Baskerville, 1991). It can be either physical or conceptual, and it is always conceived towards a specific purpose. In this thesis, physical design tools are considered to be the materials used during the design sessions, like arts and crafts, as well as cut-outs or pre-prepared backgrounds. With a conceptual connotation, tools are also the references and documentation that support the researchers in preparation of the design session (i.e. the structure document described in Chapter 4 is a conceptual tool).

Practice: the application of a set of principles into action. Co-design practice is talked about to refer to instances of involving users in design activities.

Design Project: is considered a structured work that usually has a principal design objective to achieve through a design process. Lasting from few weeks to few years, it may include several design studies with specific goals in different design phases.

Design Session: a design event in which design activities are performed. It normally has a couple of hours' duration and can involve groups of researchers and participants in the same or different design activities. One or more design sessions with the same overall design goal make a **Design Study**. In Chapter 5 I report on different design sessions.

Design Activity: any instance in which participants are involved to produce some contribution to the design. An activity will have one principal design goal, can be made of different tasks, and may include different techniques. Examples of design activities are found in the design projects presented in Chapter 3.

Design Activity Outcome: the results of a design activity – it can have different formats according to the technique employed in the activity. It can be more or less abstract, implying different approaches for interpretation and implementation before becoming an input for the design.

1.6 Methodology

The aim of this research is to develop an understanding of the practice of co-design with children and organise critical factors that are influential in it. Given the complexity of the research context and variety of the factors involved, an empirical approach based on design and development research was adopted, where a cyclic process is needed to increasingly gain knowledge of the situation and move towards an intervention (Akker van den, 1999). Therefore, the methodology applied to develop this research followed an iterative process of analysis, definition and evaluation of the research problem towards the research contribution. The diagram in figure 1.2 at the end of the section visualises the process. The research presented in this thesis has an emphasis on explorative studies and preliminary investigation of the context typical of a design research rather than product development (Ellis and Levy, 2008; Akker van den, 1999). The design and evaluation phases refer to the definition of the framework rather than of the implementation and validation of a design product strictly defined (as for the design process described in Chapter 2).

The first step was the exploration of the context of design with children, which comprised studying existing research on the literature, interacting with researchers of the field and conducting design studies with children, as represented in the diagram on Figure 1.1.

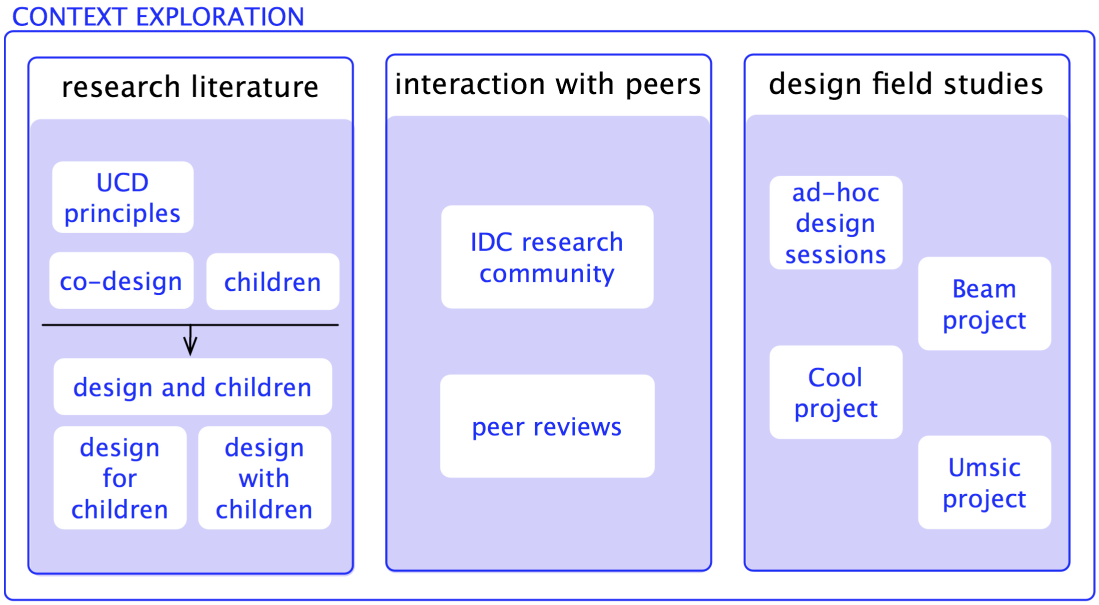


Figure 1.1 Elements that contributed to explore the context of study

For the literature review (Chapter 2), research on methods of User Centred Design and specific applications of co-design, its advantages and challenges, was examined. This analysis was followed with a study of the specific user group of children in order to merge these topics and focus on design research for children and the different approaches of involving children in the design.

Another source of knowledge for the context exploration came from direct participation in, and organisation of, a series of design projects. These studies are described in Chapter 3 and were fundamental to learning by first hand experience the implications of conducting research with children in a variety of contexts and situations.

A third category of contribution, more informal but very valuable, is the interaction with peers. Attending conferences and publishing in the field have been very useful to understand researchers' views and perspectives on the topic and to get feedback on partial findings of the research of this thesis.

The knowledge built in this explorative phase was analysed in order to identify best practices and caveats of the application of co-design with children in design research. The resulting information was then used to define an initial structure of a co-design

session (Chapter 4) as a way to organise the elements practitioners need to consider when running co-design sessions with children.

This structure was used in field studies (Chapter 5) to gain a deeper understanding of the practitioners' perception of the experience. These studies included five design sessions, each led by a novice co-design practitioner for a specific design project and targeting a different age of children. These variables (design practitioner, design aim, children's age) were varied in order to gather insights from different situations and cover a wide range of possible applications of the practice. The data collected from the studies came from interviews with the researchers, questionnaires to the children, and notes from teachers and facilitators. The results from this evaluation were analysed in a qualitative way in order to identify categories of crucial aspects of the co-design sessions. The elements that influenced these aspects were then mapped on to the structure of the co-design session, to make sure their relevance was reflected. This research process resulted in the definition of five dimensions for the framework, each with a set of important elements to consider in a co-design session. The relevance of this framework is analysed and discussed (Chapter 6).

The diagram below (Figure 1.2) gives an overview of the phases of the research and the alternation of different phases.

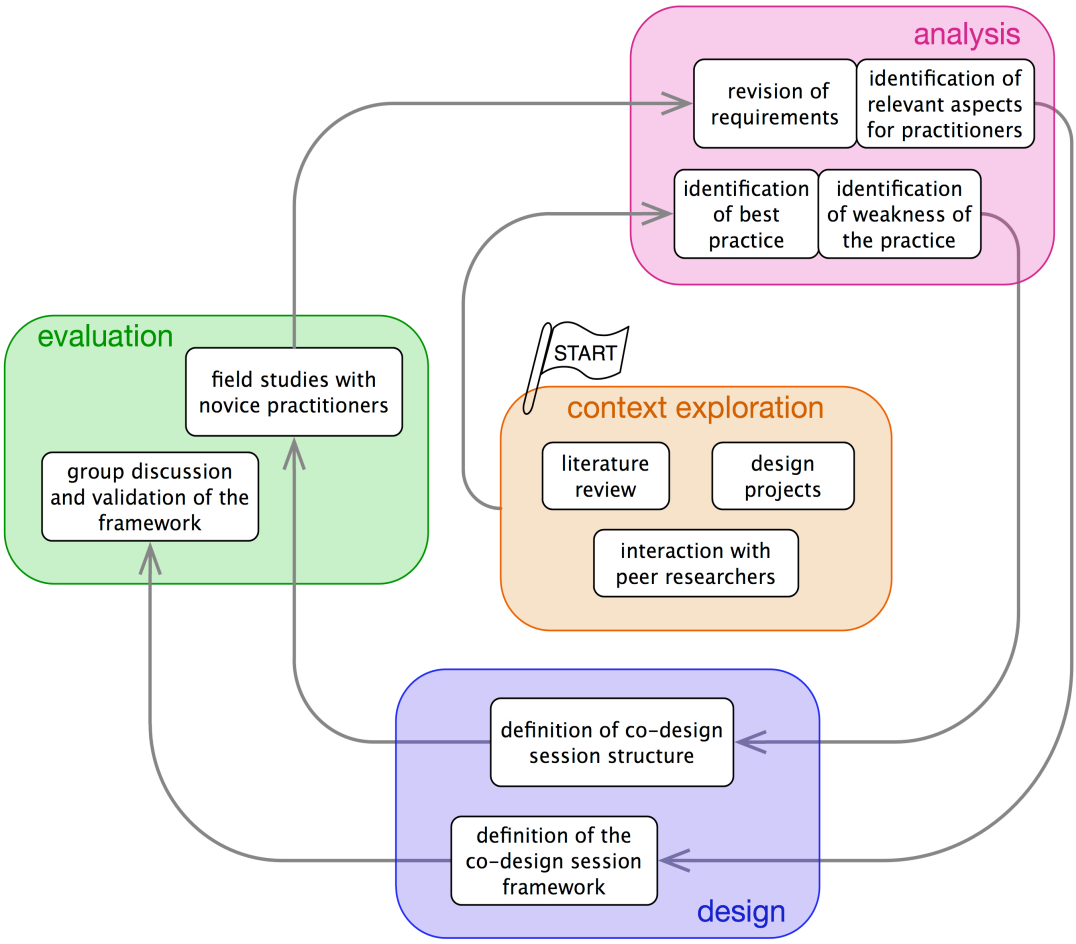


Figure 1.2 Visualisation of the methodological process

1.6.1 Ethics

The research undertaken for this thesis has been submitted to the University Ethics Committee and been approved. The researchers and the facilitators participating in studies involving children had CRB (Criminal Records Bureau) ethical clearance and were made sure to never be alone in a room with a child.

Before taking part in the studies, the parents or carers were always sent a consent form to sign, where they were informed about the nature of the study and the activities the children were participating in and the option to agree or disagree to be video recorded for research purposes. The videos recorded during the studies were viewed only by the researchers taking part in each study, safely kept in secured lockers for the duration of the project, and deleted within one year of its end. In case where some pictures or screen shots of a study have been used for dissemination purposes, the identities of children have been made inaccessible by digitally editing

the picture and avoiding faces to be seen and recognized (through cropping or using a blurring tool). For the same purpose, children's names have always been anonymised in reporting findings of any type.

During the studies, children were informed of the tasks they were expected to complete and they were made aware of the possibility to quit any time they felt uncomfortable in the activity. In cases where the studies were taking place in unfamiliar environments for the children (i.e. University labs), they were indicated the locations of fire exits and toilets to use when needed.

As for risk assessment, the University Facilities Management Department and children's schools reviewed and approved the activities plan before each study involving children took place. This process ensured that possible risks implied in the activities were foreseen and solutions accounted for.

1.7 Thesis structure

Following this Introduction, Chapter 2 presents an overview of user-centred design and interaction design and a review of related studies in the area of design for and with children, together with the discussion on methods and their application in the field. This review reports on the current state of the art of the research in the field and helps to uncover the potential and the criticality of the practice.

Chapter 3 describes the studies conducted in three different design projects for children's technologies and the lessons learnt from them. Each project has been useful to explore different approaches and techniques of co-design and build up expertise on the practice.

In Chapter 4, drawing from the knowledge acquired by looking at others' (Chapter 2) and at the author's experience (Chapter 3), the most critical aspects to consider in co-design sessions are uncovered. This understanding of the practice resulted in an initial structure of all the elements involved in a session.

Chapter 5 describes the field sessions where the structure presented in Chapter 4 was used as a prop for practitioners. Information collected from the studies and from the interviews with the practitioners contributed to the validation of the relevant aspects that affect a co-design session.

In Chapter 6, the aspects which resulted from the field studies are reflected in the framework proposed as the result of the whole research process. The dimensions and the elements included in the framework are presented, followed by an evaluative discussion with experts and novice practitioners.

The concluding Chapter 7 presents an overview of the research work reported in this thesis together with the answers to the research questions, a discussion of the achievement of the research objectives set in this introduction and a summary of the research contributions. The chapter ends with consideration of the limitations of the research work and directions for further work.

The diagram in Figure 1.3 details the flow of the research mapped onto the thesis' chapters.

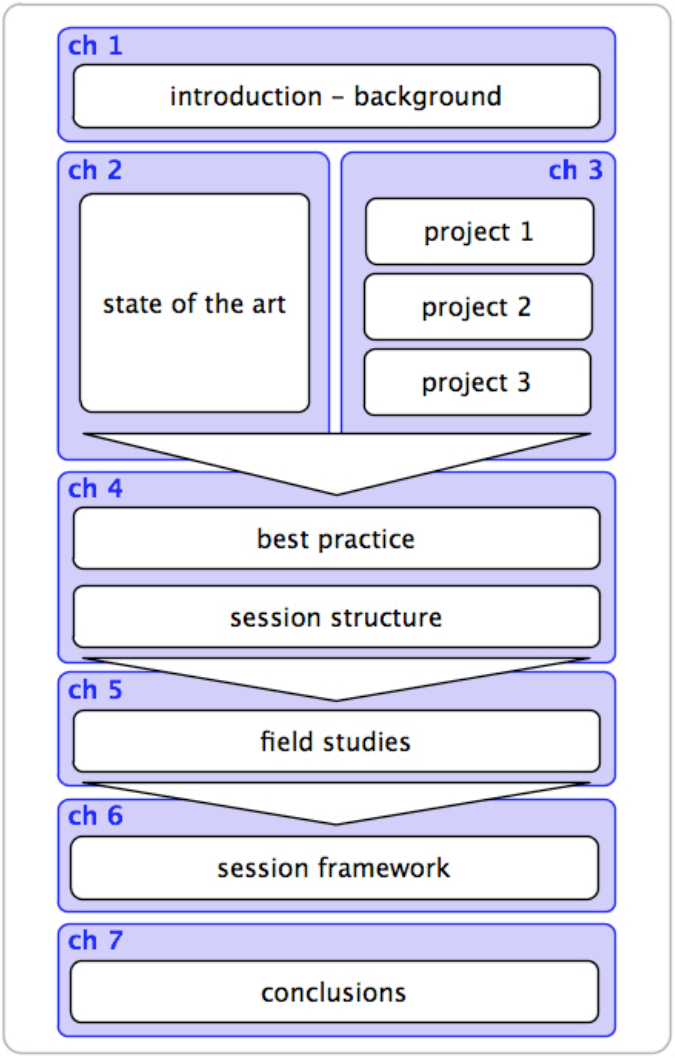


Figure 1.3 The research outline mapped on the structure of the thesis

1.8 Summary and Conclusions

This chapter has presented the research topic and research aims. This thesis aims to contribute to the discussion around co-design with children, by providing insights for reflection and practice. The framework produced as the result of this research process has an explanatory function rather than a prescriptive one (Rogers and Muller, 2006) and aims to prepare practitioners for the design rather than guide them step-by-step (Schön, 1983). While analysing the complexity of the co-design practice with children, this research also generates a review of the techniques applied in co-design sessions and the understanding of all the elements involved in the sessions.

2 CHAPTER TWO: BACKGROUND

In this chapter I present a review of the related research in Interaction Design and co-design with children. Section 2.1 includes an overview of the evolution over time of the Interaction Design discipline and its models (Section 2.1.1), in order to provide the basis for understanding the rationale behind the co-design approach (Section 2.1.2) and its implications for the design practice adopted in my research (Section 2.1.3). Section 2.2 deals with the other key component of this research: children as users. I introduce aspects of child development related to design for and with children, the ongoing research and discussions in the field (Section 2.2.1), and analyse the different methods, techniques, and criteria for applying them (Section 2.2.2).

The review and analysis of the research in the field of design with children contributes to deconstructing the complexity of the practice of co-design with children, towards answering RQ1.

2.1 User-Centred Design

At the beginning of the 20th century the focus of industry was on how machines could perform useful work. People who had access to these devices were trained as expert operators and marginally considered in the machine building process as additional components. The pursuit of efficiency prompted attempts to improve machines' controls and tasks that would fit the operators' limitations and skills. The new discipline of 'ergonomics' (called 'human factors engineering' in North America) emerged during the Second World War for this purpose, borrowing notions from behavioural science, industrial engineering, psychology, physiology or medical practice (Bannon, 1992). By having machines that were straightforward to use, users could better focus on the work to be done, completing their tasks in less time and with fewer errors.

In the early eighties use of computers began to spread in contexts of everyday life, from work to home, the 'operator' turned into a 'discretionary user' and the field of Human-Computer Interaction (HCI) made its appearance. From being considered 'human factors' as components for the system's requirements, the users started to be

seen as ‘human actors’, i.e. people with not only specific physical and cognitive characteristics, but also with needs and contingencies that would influence the way they would interact with the machine (Bannon, 1992). In the same decade, the term User-Centred Design (UCD) began to be used to emphasise this new focus (Norman and Draper, 1986). When designing artefacts of any kind, the awareness of usability matters prompted the need of shifting perspective from the object to its user. Thus, to reduce the failure of the intended use of a product, the conceptual model that the designer translates into the system was seen to need to match with the conceptual model of the actual user. Norman and his colleagues defined the conceptual model as the mental model that people create to represent what surrounds them and to understand how it works (Norman and Draper, 1986). In this perspective, two main phenomena occur during the different stages of actions of a human interacting with a machine: the gulf of execution and the gulf of evaluation. These are intended as the discrepancy between what users want to do and what the system lets them do (execution) and the discrepancy between what the system gives as an output and what the users perceive as the result of their actions (evaluation) (Hutchins et al., 1985). Therefore, to reduce these discrepancies and allow a smoother and more successful interaction it became important to understand users’ conceptual models, which also implied to understand how they behave, act and perform their activities. Ethnographic techniques were included in UCD toolkits (Dourish and Button, 1998), where lab experiments were no longer providing sufficient information and observations and explorations of real context situations were needed to comprehend how tasks were taking place. While in traditional approaches users were consulted mainly at the end of the process to evaluate and validate an almost-finished product (Rubinstein and Hersh, 1984), Gould stressed the importance of an early focus on users, and the development of iterative designs, which included continuous testing with users throughout the process (Gould and Lewis, 1985).

In 1999 the International Standard Organisation specified the fundamental principles at the basis of the User Centred approach in the ISO 13407 (ISO, 1999) now included in the updated version ISO 9241-210 (ISO, 2010). The standard is called ‘Human Centred Design processes for interactive systems’ as it considers not only ‘users’ but also all human actors interested in the systems as stakeholders. The design principles listed in the standard are:

- the design is based upon an explicit understanding of users, tasks and environments;
- users are involved throughout design and development;
- the design is driven and refined by user-centred evaluation;
- the process is iterative;
- the design addresses the whole user experience;
- the design team includes multidisciplinary skills and perspectives.

In short, the standard asserts that considering the user requirements from the beginning will help to eliminate, or at least to narrow, the gap that often exists between the way the system actually works and the way users perceive and interact with it. The standard also implies that most unsuccessful products are likely to have derived from assumptions made by the designers without considering real life context. Since users' feedback is crucial for the design of interactive systems, the design process should include iterative cycles with continuous testing and refinements. Finally, the standard advocates that the interaction of users with the system should be considered as a whole, not limited to single interactive tasks. Involving different expertises in the design team (i.e. on diverse technical, humanist, and domain-specific disciplines) will ensure that all the different aspects involved in the interaction are taken into account - each perspective adding unique value to the success of the output.

These principles, together with guidance on design activities for each design stage, are considered the key elements for achieving quality in use of a product. The rationale for following human-centred design principles is that design based on user focus delivers products that are easier to understand and use, therefore training and supporting costs are reduced while the productivity of users increases; these products will be more successful in the market by satisfying both users and providers (ISO, 2010).

2.1.1 Design Process and Models

Over the years, the shift of focus on users towards the early stages of the design implied a change in the whole system lifecycle. The traditional 'Waterfall model' used in software engineering (Royce, 1970) followed a linear flow of sequential

steps, from the requirement analysis through design and implementation to get to final testing and maintenance. This rigid process did not enable flexibility and adaptation to requirements that were quickly changing in dynamic working contexts. The need for a process that allowed for continuous feedback was reflected in Bohem's 'Spiral model' (Boehm, 1989), where risk analysis and prototyping alternated one with the other in iterative cycles, so as to address problems and related modifications before the final implementation. Although the main concern was to identify and control potential problems rather than to involve users in the process (Sharp et al., 2007), this model did recognise the importance of users and stakeholders in the requirements analysis stage.

Around the same period, Hartson and Hix (1989) presented another alternative to the linear lifecycle in the design of interfaces from an HCI perspective. They looked at how designers approached their work and identified two different modes used indistinctly: a top-down (analytic) mode, guided by a more formal analysis of the system towards the users' needs; and a bottom-up (synthetic) mode, driven by a more creative impulse, that adopted users' perspective towards the system. The peculiarity of this so-called 'Star lifecycle model' is the lack of any specific order of the activities implied in the process. According to this approach, designers can freely move amongst conceptual design, requirements specification, prototyping and functional analysis as long as the results of any activity are evaluated before moving to the following one. Although this model clearly depicts the flexibility and variability of designers practice, it does not support practitioners in tracking progress and resources (Sharp et al., 2007).

On its guidance for human-centred design processes, the ISO 13407 (ISO, 1999), now replaced by ISO 9241-210 (ISO, 2010), identifies 4 main activities that make up the lifecycle. It starts with the specification of the context of use of the product, its users, its intended goal; moves to the definition of the users requirements the system has to meet; then it goes through the creation of design solutions, either concepts, prototypes or products; followed by their related evaluation. These stages are expected to be repeated in cycles until the system satisfies the intended requirements, as represented with the dotted lines in the diagram below (Figure 2.1).

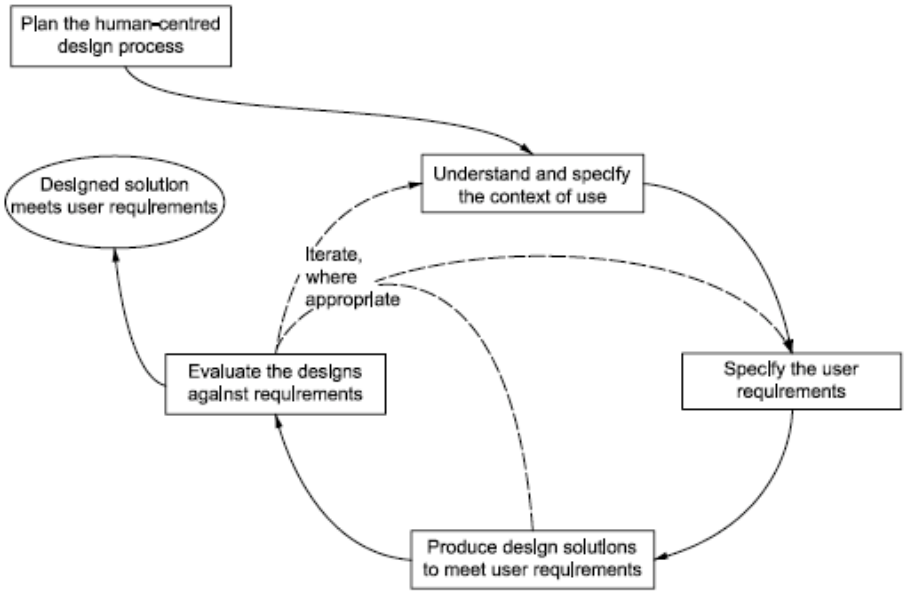


Figure 2.1 ISO 19240-210 Design lifecycle (ISO, 2010)

What is common to all these iterative models is that the outcome of each activity is the premise for the following one: the results of the analysis of the context of use would have to be reflected in the design decision, as well as the analysis of the findings from the evaluation of design ideas having to drive the changes and improvements for the following design cycle.

One criticism of these models is the tendency of each to focus on only one idea for the whole process, instead of considering many possible ideas before choosing one to analyse further, as suggested in the so-called 'funnel' models (Acklin, 2010). To address this issue, Westerlund (2005) proposed a 'design space model' that enables the representation of all the possible solutions during the design process. Rather than being a prescriptive model of the process, this model is presented as a conceptual tool that can be used for both planning and understanding design processes.

Although some models attempt to be prescriptive, they normally do not go into details on the different design methods and techniques to apply at each stage. Gulliksen et al. (2003) wanted to fulfil this lack of guidance by defining UCD key principles in detail as a support to the system development process. In their definition of these key principles for a user-centred approach to systems design they included a list of activities and tools for applying these principles in practice. For example, one of the activities for the principle 'user focus' is the identification, description and

prioritisation of user groups, while possible tools and methods suggested for this activity are user analysis and personas (Gulliksen et al., 2003). Designers can select many different methods and techniques, regardless if they are exploring requirements or testing a solution, the same method can be adapted for many different design situations (Westerlund, 2005). For a similar purpose, Bevan (2009) identified the criteria by which to select the most appropriate user-centred method according to the many different purposes and stages of a design project.

Marti and Rizzo (2003) proposed a design framework called the 'Egg model' to differentiate the levels adopted by the design according to its aims: whether it intends to improve existing products (reactive level), develop new systems (proactive level) or envision new situations of use (emergent level). Within each level, they distinguished the three main design phases – analysis, generation and evaluation – and suggested different techniques to adopt at each stage depending on the distinctive design level. Therefore, when improving existing products in the reactive level, the emphasis is on evaluation, while for the design of novel artefacts more effort is dedicated to the generation of design concepts. For the clear correspondence between design levels and design phases this model has been used as a reference for the research described in this thesis, as discussed further in Chapter 4.

Taking into consideration the models and definitions presented in this section, with particular attention to the 'egg' model, the design process adopted in the context of this research refers to three main phases – analysis, design and evaluation – repeated in iterative cycles. The analysis includes the exploration, investigation and examination of the context of use, the activities and employed tools, the users and their requirements, the intended goals. The findings from this stage inform the following phase of design, which corresponds to the creative stage and definition of solutions. This stage includes initial generation of divergent and abstract concepts, which converge into concrete ideas until later development of prototypes and final implementation of solutions. The results of the creative phase, whether an abstract idea or a concrete prototype, need to be evaluated against the design goal and requirements. Depending on the progress of the design process, the evaluation requires a different calibration: testing ideas generated in the creative phase, getting feedback on prototypes or validating products. For example, applying a usability evaluation to abstract concepts created at early stages will risk aborting potentially

good and innovative ideas before they are given the chance to go through refinement stages (Greenberg and Buxton, 2008).

2.1.2 From Participatory Design to Co-Design

Historically, as the focus on users' needs and requirements extended from evaluation phases to early phases of the design (Gould and Lewis, 1985), higher degrees of users' involvement in the design process were explored. The active engagement of users stepped to a deeper level with the Participatory (or Cooperative) Design (PD) (Bjerknes and Ehn, 1987; Greenbaum and Kyng, 1991; Schuler and Namioka, 1993). This approach to design started in the Scandinavian countries in the attempt to democratise the process of change in work organisations. This design practice was initially applied in work-related contexts for the design of computer systems to support work applications. The Utopia project is taken as a reference of the first project involving graphics trade union, a newspaper company, and design research institutions in Sweden and Denmark to develop text and image processing (Bødker et al., 1987).

The participatory approach later expanded its reach and has been explored in design for contexts other than work application: examples include leisure (e.g. the Kidpix drawing application designed by an amateur programmer with inputs from his own child (Hickman, 1991)), domestic (e.g. the Interliving research project, on developing distributed technologies to support family members of different generations living together (Westerlund et al., 2003)), and educational (e.g. the international Kidstory project, on information technologies tools for interactive storytelling (Alborzi et al., 2000)).

The philosophy embraced by participatory design regards users as critically contributing to the design with their ideas since they are held to be experts of their own daily activities and therefore capable of identifying needs, problems and strengths from their personal experience. With this approach users are directly involved in the design process as active members of the design team through different design activities. Kensing and Blomberg (1998) claimed that genuine participation happens when users actually influence the design rather than contribute only as informants. They backed this statement with practical and political reasons:

the need for a mutual learning between users and designers and the defence of employees' rights to decide on their own working conditions.

In his survey of methods and techniques of participatory design Muller (2003) defined PD as a third hybrid space in HCI, intended as a neutral zone where the designers and the end-users meet. This concept came from the idea that designers and users belong to two different worlds whose reciprocal understanding is often very difficult. Thus, the introduction of this third space, unfamiliar to both groups, creates the optimal conditions for reducing power relations and allows everyone to feel in an equal position and free to express themselves (Muller, 2003).

With a different perspective, Agostini et al. (2000) argued that ultimate design innovation cannot come directly from users. They took principles from industrial design and computer supported collaborative work to propose a different model of involving users in design called 'seductive design'. They view the creation of knowledge as the continuous intertwining of two separate processes – instead of happening in one same instance as in participatory design – user-driven and design-driven, until convergence. In this way, designers and users would continuously share knowledge until designers would be able to develop innovative applications.

More recently, Lee and Bichard (2008) proposed a framework of Design Participations as a continuum based on the level of involvement of the different stakeholders and their role in the design process. The flow goes from 'design innovation', in the realm of designers' expertise, where users have only a passive role, until the 'design motivation', where the design is led from the users in their concrete space and the designers have more of an 'executors' role. In between there is the 'design collaboration', in which resides Participatory Design, where designers and users work together as partners.

Since the beginning of the 21st century the terms 'co-design' and 'co-creation' gained popularity when referring to user and designer collaborations. Sanders (1999) brought the co-creation practice into industry and developed a toolkit[1] as a way to disseminate the practice. She distinguished between traditional design methods, that mainly use observational and ethnographic research, focusing on what people do,

[1] www.maketools.com

and traditional market research, which primarily uses surveys, questionnaire or interviews to consider what people say and think. At a deeper level, co-design allows users to take part in design sessions and shifts the focus on what people make, as an expression of their ideas, thoughts and perceptions that may not emerge from conventional enquiry methods (Sanders, 1999). Westerlund (2006) represented this concept in a neat diagram as in Figure 2.2. This diagram shows an example of a way to classify the variety of techniques and related objectives of including users in design.

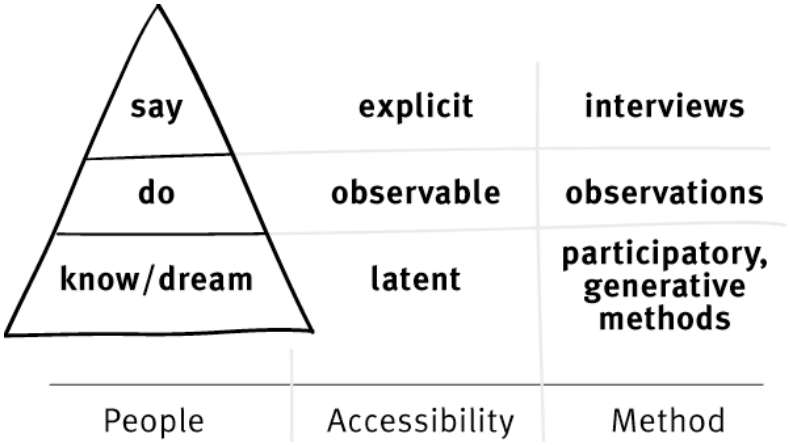


Figure 2.2 Levels of access to information on users (from Westerlund (2006))

In 1993 Muller et al. (1993) presented one of the first taxonomies of all the practices involved in PD and they based it on the different stages of the design process and the degrees of active involvement between users and designers. Their aim was twofold: to provide a practitioners' guide of the fast growing PD practices and to highlight that those practices were used also outside research contexts and outside Scandinavian countries, in response to the critiques on the limited application of PD in different contexts.

2.1.3 Considering Co-Design in Practice

As already noted by Muller et al. (1993) there have been contradictory reactions to the applications of UCD and PD methods in industry. The time and resources required for user studies were seen as suitable only for research contexts, where length of time and variety of resources can be more flexibly adapted to those practices. Also, results are not immediate and straightforward, even if the benefits

are then manifested in quicker and more efficient ways of reaching the market by targeting the needs and meeting the requirements.

Other obstacles to user involvement identified by Poltrock and Grudin (1994) were the rigidity of organisational structures and the need for a global commitment, together with the difficulties in accessing users and planning the activities, analysing the results and conveying them to the developers. Kujala (2008) recognised the difficulty in analysing information derived from user studies and addressed this challenge by presenting different examples of how the analysis can be applied to the design. With these examples she showed the variety of the applications of user involvement in different design stages, whether identifying the context of use, users' values or tasks sequence. Although there is no 'one-fits-all' formula, her research demonstrated the importance for product developers to be actively involved in gathering information directly from users.

In analysing the design landscape on the first decade of the 21st century, Sanders and Stappers (2008) listed several reasons for the considerable delay (as it was already envisioned in the first conference on Design Participation in 1971) that the participatory design and co-design practices took in making an impact in the 'man-made world'. Back in 1971, the need for participation of citizens, not only in the moment of decision but also in the generation of ideas, was foreseen as a way to overcome future design failures and limitations. In the closing remarks of that same conference, it was already predicted that it would take a long time to prepare designers for this change of approach (Cross, 1972). It was envisioned that such change had to overcome cultural barriers and accepted beliefs, especially in business contexts and highly hierarchical structures, and to accept that not only 'lead people' can be consulted in decision-making or idea generation. Co-design requires everyone to be creative: researchers, designers, clients, stakeholders or final users/customers.

Despite all these benefits in the medium-long term, the procedure of involving users in design processes is still largely confined to research contexts, and it is quite difficult to find business and manufacturing organisations, especially small to medium sized ones, who actually use this practice as many companies do not see an immediate financial benefit. Most of the successful projects applying a participatory design approach happen in academic contexts or in big companies. Pioneers in this

practice have been Xerox Research Laboratories, investing in usability research since the early 1980s. Nowadays the scene is changing, with user experience being the added value that makes the difference in a highly competitive market, together with users and customers that assume a less passive and more responsible role as active players (Sanders and Stappers, 2008).

Although not every company decides to invest in extensive co-operation with users, there is an increasing tendency of consulting them already in the early stages of the design process, a trend that is spreading with the growing industry of service design and social applications (Steen, 2011). These days, many companies, like mobile telephone companies such as Nokia or Motorola, have an active Interaction Design Department within their production process, while smaller companies contact design consultancy agencies. Examples of applied co-creation strategies are: to encourage users to try beta versions and provide feedback for improvement before release, as in Nokia Betalabs[2]; or to offer customers online tools for 'designing' their own product, as in NikeID online store[3] or Lego's 'Design by me'[4]. Other companies launched design competitions as another way to consult users and implement their ideas, as did BMW Virtual Innovation Agency[5] in 2006.

Co-creation is used as a generic term to refer to "act of collective creativity" (Sanders & Stappers, 2008). Co-creative activities are a combination of research, play and learning and, when applied to the design of products or services, can assist designers in broadening their perspective and developing new insights. Co-design, as a method for both inspiration and gathering information, requires the designer to be skilled at facilitating, listening and observing without imposing personal filters (Shackleton, 2010). This definition cannot be interpreted too rigidly, since the analysis of the co-design output requires interpretation and cannot be exempt from the designers' influence. The different occurrences of the collaboration with users depend on the designers' ability to adapt the different tools and techniques to each design context and need (Kujala, 2003). However, this 'designer bias' is not to be

[2] http://betalabs.nokia.com/about

[3] http://nikeid.nike.com/nikeid/index.jsp

[4] http://designbyme.lego.com/default.aspx

[5] http://www.bmwgroup.com/e/nav/index.html?http://www.bmwgroup.com/e/0_0_www_bmwgroup_com/forschung_entwicklung/menschen_netzwerke/forschungskooperationen/via/anforderungsprofil.html

considered negative a priori, as co-design is supposed to draw out inspirations and insights from users' contribution, and not to substitute the designer with the user. Many critiques to PD and UCD approaches advocate that users have been more valuable in helping defining a system rather than designing it (Bailey, 2005), and that true innovation cannot come by users, as they can usually answer only in relation to what they already know and use and cannot foresee their acceptance of products that do not exist yet. Real breakthrough innovations have been proved to come from talented designers and creative thinkers, based on their skills and visions (Skibsted and Hansen, 2011; Baumgartner, 2011).

The critical point in this debate is how to interpret users' involvement. Involving users does not mean asking them 'can you please tell me what your needs are?' or 'can you please invent something really useful and easy to use for you?' (Steen, 2008). The co-design practice does not intend to replace designers with users but, on the contrary, it requires designers' skills and abilities to examine, understand, analyse and translate the information coming from user studies into requirements and valuable inputs for design. Therefore, the way users are involved and the design implication of this involvement needs thorough reflection and has to be included as part of the design thinking process. As also argued by Siu (2003) the role of the designer is to facilitate the two-way communication with the users of their products. The ability of designers to consider users during the design process requires also responsiveness to the increasing variety of user groups and contexts, already far away from the initial 'adults in the work station'. Children are one of the specific groups of technology users that designers have started to focus on since the 1990s, as they represent a growing target group in terms of both their number and their economic potential (Markopoulos and Bekker, 2003).

2.2 Design and Children

2.2.1 Understanding Children in Design

In the same way as for any system designed with a user-centred approach, systems intended for children have to focus on children's needs and contexts of use. In the case of child users, the discrepancy between the system's conceptual model defined by adult designers and the user's conceptual model (Norman & Draper, 1986) is even greater than for adult users. Most of the interactive products and software that are

intended for children are typically designed and built by adults who often are far from knowing how young users handle technology and what they need from it. Children's perception and representation of the world is in continuous development and it is largely different than the ones of adults. One of the first aspects to consider when designing for children is their cognitive development stage, which conditions their thoughts and behaviours. Children's cognitive development concerns not only the way they acquire knowledge, but also the development and construction of their mental model of the world, which allow them to use information from past experiences or to plan future actions. Piaget and Vygotsky are two of the most referenced cognitive psychologists in this respect.

Piaget took children's thinking seriously, recognising that they do not think like adults but have their own logic and structure, grounded in their needs and possibilities (Papert, 1999; Ackermann, 2001). In his 'genetic epistemology' framework, Piaget (1952) studied how knowledge develops in human beings through four main development stages connected to the specific acts of intelligence at the base of physical and mental patterns. He defined these four stages in relation to the age:

- until 2 years old, the sensi-motor stage, where intelligence is in the form of motor action;
- from 3 to 7 years old, intelligence becomes intuition in the pre-operational stage;
- from 8 to 11 years old is the concrete operational structure, intelligence starts to be logical but still refers to concrete referents;
- finally, from 12 to 15 years old is the formal operational structure, where the thinking involves also abstract reasoning.

This categorisation of stages is still widely used in all studies regarding children's development.

While Piaget's main belief was that human development derives primarily from a genetic progress defined by the combination of heredity, physical experience and social transmission, Vygotsky (1978) adopted a more socio-constructivist perspective and emphasised the critical role of social interactions in mental activities

in order to achieve a full cognitive development (ETR Associates, 2007). Following the socio-cultural tradition, he claimed that knowledge building is a collective process mediated by cultural tools and artefacts. To explain the learning process he defined the Zone of Proximal Development as the discrepancy between the child's actual development and the potential he/she can achieve with external aid from a tutor or expert. According to Vygotsky's Social Development Theory, a child's cognitive development occurs first at a social level, through the interaction with others (inter-psychological level) and then at the individual level, within him/herself (intra-psychological level) (Vygotsky, 1978). Rather than an innate characteristic of the person, cognitive development is the result of the physical, social and cultural interaction with the surrounding context.

While sharing Piaget's constructivist perspective that knowledge is built through experience and amongst individuals and groups, Papert developed the 'constructionism learning theory', on the basis that this knowledge can be built through the engagement of artefacts in social contexts. The use of external media is fundamental for externalising ideas and concept, exploring and negotiating meaning (Papert and Harel, 1991; Ackermann, 2001).

In order to provide designers with knowledge on what children of different stages are capable of, the Lego® Learning Institute produced a 'whole child development guide' (Ackermann, 2004), later on, shared as public domain to be accessible to parents, educators or researchers in the field. In this guidance for designers, the author identified four natural 'fields for curiosity' that prompt the growth of the child to adult, that are:

- 'me' – how children develop knowledge themselves and the way they use their own body;
- 'us' – how children develop the way they relate to others and they build understanding of others;
- 'world' – how they explore and investigate what surrounds them and they start making logical connections and build structures of the whole;
- and finally 'creativity' – how children envision alternatives and handle fantasy worlds.

For each of these aspects, Ackermann analysed the competencies children are pursuing at different ages and how they can be supported in the process. Although the analysis is divided into age stages, developmental stages are only loosely connected to age and there can be much difference in how each child develops.

Most research on design for children stresses the importance for designers to take into account children's cognitive development, as reported in the following examples. Baumgarten (2003) provided an overview of how children's use of internet varies along the different developmental stages (from age 2 to 14) by looking at physical, cognitive, and psycho-social characteristics of children at each stage, as well as their disparate interests, likes, dislikes, and fears. She highlighted the importance of producing high-quality internet programmes that best address children's needs and preferences in relation to child development aspects. This approach can turn children's exposure to the internet from passive and detrimental activities to interactions that promote creativity, learning, challenges and excitement.

Gelderblom and Kotzé (2009) supported the belief that designers of children's technology cannot make intuitive assumptions on children's requirements or simply ask them about their preferences. They advocated that research about young children, including cooperative design, requires knowledge and experience that designers should gain from experts and developmental psychologists. Therefore, they created a set of design guidelines out of a detailed research in literature on psychological theories of children's development, children's use of technology and existing design principles of children's technology. The authors focussed on children aged 5 to 8, as considered those with a rapid growth of cognitive abilities and for whom the use of appropriate tools can enhance and support the acquisition of cognitive skills. They edited 150 guidelines divided into 5 categories and summarised in 10 main 'lessons learnt'. Although they did not depreciate the value of usability testing to achieve successful products, they believed that following proper guidelines can reduce development costs and usability tests needed.

When creating a catalogue of design principles for children's technology, Chiasson and Gutwin (2005) analysed a wide range of research on children's technology design. They identified the design principles that emerged from their analysis and organised these into areas of cognitive, physical and social/emotional development,

each to be adapted to different age groups. While all sets of requirements are equally important to meet users' needs, they noted that principles relating to cognitive and physical factors are more clearly defined and easier to incorporate in the design than the one relating to social and emotional aspects, which are more dependent on specific goals and conditions. More research is still needed in this area in order to achieve the same level of details and at the same time design principles need to continuously evolve as new technologies emerge.

In the field of tangible interfaces, Antle (2007) detected the need of grounding design on developmental theories about how children develop intelligence through their physical, social and spatial interactions with the world. With the aim of informing and inspiring the design of tangible interfaces, she created an explanatory framework combining attributes that are specific to tangible interactions with relevant theory about children's cognitive development.

As reported above, theories and guidelines are useful to get oriented on children's needs, but children, as a user group, are so diverse and complex that their direct involvement in design is necessary to ensure requirements are met (Druin et al., 1998; Markopoulos and Bekker, 2003).

2.2.2 Design with Children

Since designers have to confront issues of cognitive, social and emotional development that are difficult to generalise, survey methods like observations and interviews may not be sufficient for gathering requirements and understanding needs of children users. Based on the participatory design tradition (Greenbaum and Kyng, 1991), an increasingly used practice in design projects includes children as contributors in the early stages of design.

Making users create things, instead of only asking them about a topic or observing their behaviour in specific situations, will take the researcher or developer to a deeper level of the users' way of thinking and their understanding of the world (Sanders, 1999). When it comes to children, practical activities also help overcome limitations that arise from their still-to-develop language and social skills, and at the same time encourage their potential for creativity and imagination (Williamson, 2003; Baek and Lee, 2008). Including users of a young age during the design process provides novel and interesting contributions to the design, enabling developers to let

go of their own assumptions and generate more innovative and creative outputs. By getting insights on children's worlds designers get closer to children's perspective, reducing the risk of building inadequate products (Facer and Williamson, 2004). This practice aims at minimising the skill and knowledge differentials between designers and users and at improving the success of the final product. When users and designers come together, the relative influence of each party determines the nature of the participation. When the users doing participatory design are children, there are several extra tensions including subject knowledge, skills and power relationships that affect the amount of influence that each party exerts (Read et al., 2002). Despite the practical difficulties implied in involving users in the design process, there is an increasing interest in this approach by both experienced researchers, who have used it and keep investigating it, and novice researchers who see its potential (Yarosh et al., 2011).

In the interaction design and children community, works by Druin (Druin et al., 1998; Druin, 2002) are amongst the most widely cited when it comes to design for and with children. Druin (2001) distinguished the different roles children can take throughout the design process, namely: users, testers, informants and design partners, differentiated according to the degree of contribution and the design stage of their intervention. While the roles of users and testers refer to the evaluation of products, those of informants and designers relate mainly to the design phase.

The term 'informant' was first used by Scaife et al. (1997) and describes a process by which children contribute with their ideas to the overall design of a product but are not continuously involved in the whole design process. Druin (1999) introduced the Cooperative Inquiry (CI) methodology to engage children in participatory design through an extended period of time, where children are considered equal design partners. CI is closer to the ideal of design partner and suggests greater equality between children and adult designers, together with a larger involvement of the children than in informant design and a democracy of ideas.

Whereas longitudinal, cooperative and small group design situations, as promoted in CI, are clearly very beneficial, they are not the most common situations in research projects. In his discussion on the participation of children in the design of new technology, Williamson (2003) considered the CI method as less practical than

informant design, since it requires resources and time that are not easy to find in most research projects, especially if they involve partners from industry. Another drawback he mentioned is the limited number of children involved, which precludes the participation and contribution of larger numbers. As also noted by Nesset and Large (2004), rather than full design partners, children can be easier involved at salient parts throughout the design process as critical informants (Scaife and Rogers, 1998).

An alternative to arranging extra-scholar activities, the most direct way to access children aged between 7-10 is through the school system. Based on Learning Centred Design from Guzdial et al. (1995), Rode's work (Rode et al., 2003) shifted the context of CI to the school setting, highlighting the importance for design to fit in the national curriculum. In their Curriculum Focussed Design, the authors presented advantages and disadvantages of working in schools during teaching hours. The challenges encountered in this setting have mainly to do with the adaptation to a structured environment, with a rigid time schedule and higher probability of interruptions from daily activities running in the school, all factors that require detailed planning. Running design sessions in schools is ideal in terms of accessing a wide number of children in their natural environment during their everyday life activities. School based activities save the extra work related to arranging children's transport, requesting permissions, and risk assessments (all needed when school children are invited to university labs). On the negative side, the research activities in schools have to comply with the rigidity of the time schedule, space arrangement and the need to bring the equipment required for the study. Difficulties in organisation, arrangements and coordination are also one of the reasons why whole classroom projects are not so commonly reported in studies (e.g. Garzotto, 2008), although more compliant to principles of inclusive design. Most studies involve a limited number of children per session and little explanation is given on the selection criteria (e.g. Brederode et al., 2005; Dindler et al., 2005; Verhaegh et al., 2006).

What is common to any of these situations, whether at schools, in university labs or other settings, and whether the collaboration is limited to a single event or extended in time, is the need for researchers to be acquainted with all the aspects implicated in the design session.

2.2.3 Design with Different groups of Children

In 2004, the UK Association of Usability Professionals held a dedicated meeting to address expectations, strategies and practicalities for User-Centred Design with children. In analysing differences with adults, they highlighted that children's ability to understand, verbalise, write, concentrate on tasks, and their predisposition to please or disrupt widely depend on their age and those are the factors that most affect the data collection in users (Demming, 2004). The vast majority of the studies with children refers to the age group between 7 and 11 years old, which is considered the most suitable developmental stage of young prototype partners (Druin, 1999; Bruckman and Bandlow, 2003).

In their book chapter 'HCI for kids', Bruckman and Bandlow (2003) presented a review on the influence of children's characteristics on HCI research and on the design of interactive technologies, based on Piaget's cognitive development of children. They reported that the participation of children as design partners depends mainly on their age. In particular:

> *Children younger than 7 years have difficulty in expressing themselves verbally and being self-reflective. These younger children also have difficulty in working with adults to develop new design ideas. Children older than 10 are typically beginning to become preoccupied with pre-conceived ideas of the way "things are supposed to be." In general, it has been found that children aged 7-10 years old are the most effective prototyping partners. They are "verbal and self-reflective enough to discuss what they are thinking," and understand the abstract idea that their low-tech prototypes and designs are going to be turned into technology in the future. They also don't get bogged down with the notion that their designs must be similar to pre-existing designs and products.* (Bruckman and Bandlow, 2003)

Although this is the most common age range studied in research on design for children, research interest is growing around toddlers and teenagers user groups, as highlighted by Yarosh et al.'s review of 10 years of IDC (Interaction Design and Children) publications (Yarosh et al., 2011).

Children over 11 years old are considered to have already started being aware of what the 'right answer' is supposed to be while losing the spontaneity of the creative thinking (Read et al., 2006). Another possible reason for the fewer research studies on this age range is that working with teenagers is considered more demanding and more challenging due to the particular developmental stage. Adolescence is

considered a difficult age: on the border between childhood and adulthood, teenagers thrive for their own identity and have a stronger self-consciousness which often results in conflictive relationships with adults where the power-relation starts to be questioned. Teenagers are indeed an interesting and challenging age group to work with, but working with them requires additional attention on the choice of design methods and communication tools (Dashiff, 2001). The absence of a standard practice implies adapting the design sessions every time to the contingent participants' response. For example, Isomursu et al. (2002), in reporting their research for creating a mobile device for girls between 10 and 16 years old, highlighted difficulties in communicating with teenagers through interviews or face-to-face methods. The authors had to resort to the use of a web-based storytelling environment to collect valuable input from user groups of this particular age. The work from Danielsson and Wiberg (2006) presented an adaptation of participatory design to the context of designing an educational computer game for teenagers aged 13-15. After analysing what worked and what did not work with the teenagers, the authors opted for open design sessions after noting that the participants preferred focus group discussions to workshops with printouts and pens. They concluded that the crucial contributions from the teenagers' input concerned the areas of game contents, aesthetics and experience, and, without their contributions on these elements, the game would not have reached its target user group.

Similarly, younger children are another user group that is receiving growing attention (Yarosh et al., 2011). Toddlers' limited communication skills and cognitive abilities need to be addressed when implementing interfaces for that specific user group (Gilutz, 2009), as well as when planning co-design sessions with them and adapting design methods, e.g. prototyping (Niemi and Ovaska, 2007) or card-sorting (Joly et al., 2009).

Another research area which is increasingly being investigated in the field of co-design with children is to design for and with children with special needs. The characteristics of this special group of users (e.g. limited communication, cognitive, motor skills) make it difficult to gain direct access to the users. Parents, carers, tutors, or therapists are usually required in the design process as having direct knowledge of the special need users and also as having to use the designed technology. As well as delivering specific interactive products, research in this area

has also developed frameworks and models to follow when including children with special needs in the design process (Guha et al., 2008; Kärnä et al., 2010).

The research in this thesis mainly refers to children aged between 7 and 11 years old, the age range most accessible and commonly involved in design studies, as reported earlier. However, the basic principles expressed in this thesis can be adapted and applied to understanding the specific needs of younger and older children.

2.2.4 Overview of Different Techniques of Co-design with Children

Designing with users of any age makes use of a large spectrum of design activities, every time adapted to specific design circumstances. Much research is going into reporting instances of applications of different techniques and approaches (e.g. Dindler et al., 2005; Druin, 1999; Vaajakallio et al., 2009, as detailed later in this section) and into producing guidelines and principles to successfully employ these approaches (e.g. Williamson (2003) reporting implications for designing educational technologies; Kelly et al. (2006) combining experts' design with children's contribution; or Seymour (2001) with a step-by-step guidance in participatory process for schools).

This section first provides an overview of the approaches and techniques applied in research on co-design with children and then examples of different ways to classify these research methods. Finally it presents a list of techniques according to parameters that are relevant for the practice of co-design with children.

For her Cooperative Inquiry method (Druin 1999), Druin identified three main techniques comprised in the method that enrol children as designers:

- the 'contextual inquiry' to collect data on the users' environment;
- the 'low-tech prototyping' to represent their design ideas;
- and 'technology immersion' to explore different technologies to be included in the design.

Kundzton et al. (2003) reported their application of the Cooperative Inquiry method to a research project and reflected on the lessons learnt while building an intergenerational team. They produced a set of guidelines as recommendations for anyone wanting to undertake similar types of research. Based on cooperative inquiry,

the same intergenerational group at Maryland subsequently developed a collaborative co-design technique called ‘layered elaboration’ (Walsh et al., 2011). This technique builds upon storyboarding for interactive media, paper prototyping and annotation tools and enables adult and children designers to add to each other’s ideas by using acetate sheets one on top of the other. In this way none of the ideas get lost and flexibility of changes is guaranteed.

Researchers (Iversen and Brodersen, 2008) in Denmark introduced a design method within the Participatory Design methodology, called ‘Bridge’, based on a socio-cultural theoretical framework. Bridge was developed for children users, although its principles can be applied to any community of practice. According to this framework, children are not considered only with regards to their cognitive development but also to their personal circumstances, where the social practice plays a significant role. The authors claimed it differs from other contributions in Child Computer Interaction research for considering children on the basis of their own specific social practice, rather than for viewing them as incomplete cognitive beings. The techniques proposed for this method resulted from adapting and developing further already existing practices established in the Child Computer Interaction research. ‘Mission from Mars’ is one of the techniques used in the Bridge method and was first applied to support the design of an eBag (Dindler et al., 2005). This technique used interviews and role-play by asking children to describe the content of their schoolbags to an extraterrestrial character (i.e. a Martian). The emphasis on fun and playfulness creates a motivating framework for children to provide detailed and useful information to the designer in ways they are more familiar with. Verhaegh et al. (2006) adapted this technique to the design of a more abstract topic, an outdoor game, and confirmed its motivational value with children. Another method for eliciting user requirements from children has been previously presented by Bekker et al. (2003) as the KidReporter method, where children act as reporters and create stories about selected topics by using different media: pictures, interviews, articles. The assumption behind this method is that, by engaging in these activities, children would naturally disclose to designers things that are important to them.

Apart from reporting the outputs of specific projects, many researchers also reflect on the practice itself and focus on its methodological implications. Techniques normally used in Participatory Design workshops for adults need to be adapted to the

level of the cognitive development of children, so as to facilitate them to express their ideas and contribute effectively. Baek and Lee (2003) developed a participatory design technique to design children's websites based on the cognitive characteristics of children. They created a generative toolkit, InfoBlock and InfoTree, for children to elicit abstract and complex concepts such as information architectures and navigation structures. In doing this, they adapted the design of a web portal to the mental concepts of children, which differ from adults' conventional logic and rational thinking.

Brederode et al. (2005) reported their experience of involving children with different abilities throughout the different phases of the design, from initial interviews and observations, to concept and product evaluation. The authors also noted designers' increased knowledge on users derived from continuous contact with children, compared for example with other researchers involved in the project but not in the sessions with children.

Another example of how designers adapt and apply co-design techniques in their search of understanding the context of use of children's products is the project described by Hallam (2010) for the re-design of a legendary children's product like the Barbie™ doll. He combined scenarios and craft practice together with card-sort and survey methods in a co-design experience with children in order to meet actual values and needs of contemporary users.

In another study, Jones et al. (2003) reflected on the application of Druin's guidelines for cooperative inquiry (Druin 1999) and stressed the uniqueness of each project and therefore the necessity for deeper understanding and adaptation of generic guidelines. Similarly, Vaajakallio et al. (2009) adapted co-design games (e.g. Sanders' Make Tools (2006)) usually successful for adults with children. They reported difficulties in finding useful results according to expectations and reflected on the different ways to adapt the toolkits for children. In another study, Hemmert et al. (2010) explored new possibilities by adjusting drawing and sketching techniques to children's needs and abilities.

There is a huge variety of techniques that each time are tailored to specific projects' needs. Many have come to classify techniques according to different dimensions:

from participants involved to attributes of the outcome, from phases of design to types of data.

As mentioned earlier, Muller et al. (1993) created a taxonomy of participatory design techniques based on their position in the developmental cycle or the degree of participation between users and researchers. In a similar way, Rohrer (2008) categorised methods of user experience research according to three dimensions: data source, whether they are attitudinal or behavioural, focussing on what people say or on what they do; approach, qualitative or quantitative; and degree of use of the design product. In his classification, Rohrer also distinguished methods according to the phase of the design process and confined participatory design methods as mainly qualitative and attitudinal. In analysing design methods for children's technology, Sluis-Thiescheffer et al. (2009) saw this view of participatory design methods as quite restrictive and proposed a new set of creative methods for design that spread over the data source and the approach dimensions.

Jensen and Skov (2005) classified methods used in research with children according to the context of use (natural vs. controlled) and the research purpose (from understanding to describing, through engineering or evaluating) and described the strengths and weaknesses of each method.

ETR Associates (2007) analysed a set of methods used for collecting data in research with children (e.g. diaries, interviews, observations, surveys) and listed their advantages and disadvantages depending on the reliability of the information retrieved or the ease of use for the children, according to their developmental stage or communication skills.

Finally, Sluis-Thiescheffer et al. (2011) classified design methods by associating them with the skills required from children to be suitably involved. The classification of skills is based on the theory of Multiple Intelligence (Gardner, 1993) and aims to support the selection of methods in research projects by considering the most appropriate methods given the skills of children in each particular developmental stage. They divided methods of early design in groups requiring: only communication skills (linguistic and interpersonal); skills related to perform specific design activities (linguistic, interpersonal, spatial-visual and bodily-kinaesthetic); or domain specific for particular design contexts (i.e. logic-mathematical, intrapersonal,

musical). Two methods they described as proved to be effective in design research with children are ‘nominal group technique’ and ‘prototyping’: the first one involves mainly communication skills, where children develop ideas individually and then share them in a group, while the second one includes also visual and dexterity skills.

The result of the analysis of the different approaches and techniques derived from the literature presented in this chapter is the collection of methods presented in the table below (Table 2.1). Most of the listed techniques can be applied in different ways depending on the purpose they suit, as for example ‘role-play’ or ‘card-sorting’ can be used to generate ideas or validate scenarios. Therefore, the methods are listed in alphabetical order, to stress their flexibility and non-strict dependence on phases. Far from being exhaustive, this list aims to cover most of the basic different techniques from which the design activities can take inspiration.

I have merged the different dimensions of categorisation examined earlier and considered the most relevant to designing with children. Therefore, in Table 2.1, each technique is accompanied by:

- a brief description and aim;
- its possible application according to the purpose, whether they are methods preferably used to explore the context (exploration), to generate concepts (generation) or to evaluate them (evaluation), although many techniques can be adopted in different phases with different objectives;
- examples and references of specific applications or variations;
- required skills of the children to use it;
- possible positive and negative aspects of its application.

Table 2.1 Techniques used in design with children

Technique	Description - Aim	Suggested design phase	Examples of application	Required skills	Advantages	Disadvantages
Bodystorming	Generate ideas by performing	Generation	(Oulasvirta et al., 2003)	Bodily-kinaesthetic	No need of literacy skills; engaging; inspirational; context related	Abstract results
Brainstorming	Thought shower of ideas with more or less constraints	Generation	Talked (Sluis-Thiescheffer et al., 2007), written, drawn	Linguistic, interpersonal	Quick way to generate many ideas	Need contextualisation
Card-sorting	Organise categories for understanding navigation patterns and information architecture	Exploration; Generation; Evaluation	Card sorting (Spencer, 2009), visual card sorting (Joly et al., 2009); InfoTree (Baek and Lee, 2008); tangible: InfoBlock, (Baek and Lee, 2008)	Logic	Insight of children's perception of the world	Requires thorough analysis
Contextual inquiry	Gather children's perception of the context	Exploration	Children observe, take notes, (Druin, 1999), interact in the context	Linguistic, interpersonal	Experience of context of use from children's perspective	Need detailed explanation from children for interpretation
Cultural probes	Provoke inspirational response by handing to the children a home pack	Exploration; Evaluation	(Gaver et al., 1999), playful probes (Bernhaupt et al., 2007), photographs	Visual/spatial, linguistic	Gives first-hand insights in children's daily life and personal perceptions	Time consuming both for producing the kit and analysing the results Mainly inspirational
Diaries	Children's report on daily activities in context	Exploration	Written, visual (drawing, photos), (Berry and Hamilton, 2011)	Linguistic, intrapersonal	Gather detailed information in context and close in time to the events; Relatively easy for children to complete	Depend on children's commitment Time consuming analysis
Drawing	Visualisation of ideas and context	Generation; Evaluation	Free drawing (i.e. Pictive (Muller, 2003) Drawing intervention for evaluation (Xu et al., 2009)	Spatial/visual	Familiar to the children; Easy way to communicate ideas; Keep some level of fantasy and imagination/abstractness	Need detailed explanation from children to avoid mis-interpretation
Focus group	Gathering children's collective opinions/ideas on specific topic	Exploration; Generation; Evaluation	Group discussion, guided discussion (Hennessy and Heary, 2005)	Linguistic, interpersonal, social	Allow detailed exploration of topic ad different perspectives in a single session; Comfortable for children	Influenced by group dynamics and leader effect
Future workshops	Envisioning fantasy future technology	Generation	(Kensing and Madsen, 1992)	Spatial/visual, linguistic	Good for divergent phase of ideas generation	Abstract results

Interviews	Gathering children's individual opinions/ideas on topics	Exploration; Evaluation	(ETR Associates, 2007)	Linguistic, interpersonal	Explore details No need of children's literacy skills	Time consuming Needs interviewer skills to avoid biased answers
Presentation	Children present their idea, with or without props	Exploration; Evaluation	To peers (i.e. Bluebells' Blind Man's Bluff (Kelly et al., 2006); collective presentation); to fantasy characters (e.g. Mission from Mars (Dindler et al., 2005));	Linguistic; interpersonal	Provide useful information on children's explanation of their ideas	May be conditioned by social factors and children's linguistic skills
Prototype	Represent and explore ideas and concepts	Exploration; Generation	3d, drawn, (Muller, 2003)	Bodily kinestetic; spatial/visual; interpersonal	Engaging; Allow role play; Allow thinking of practical constraints	Can be influenced by available material Time consuming in doing and analysing
Questionnaires	Gathering specific and measurable information	Exploration; Evaluation	Multiple choice, open questions, Likert scale, Fun Toolkit (Read and MacFarlane, 2006)	Linguistic	Provide large amount of data in little time; Measurable quantitively	Children may misinterpret questions Depends on children's literacy skills
Role-play	Evaluate a concept by acting out use	Generation	Perform a scenario (Seland, 2009)	Bodily kinestetic; interpersonal	Engaging; encourages natural behaviour; shows ideas in context of use	Ambiguous interpretation of resulting ideas
Scenarios	Stories describing use cases, including events, settings, actors, tools	Generation; Evaluation	Written (Carroll, 2000); Drawn.	Logic; linguistic; bodily kinaesthetic (3d); spatial/visual (drawn);	Structured and contextualised information	Depend on children's narrative and linguistic skills
Sketching	Detailed drawing of a concept with description	Generation	Drawing and text, labels, (Hemmert et al., 2010)	Spatial/visual; linguistic	More informative than simple drawings	Needs some abstract thinking from children and writing skills
Storyboarding	Visual representation of a scenario	Generation	Comicboarding (Moraveji et al., 2007); 3d (e.g. plasticine (Mazzone et al., 2008b));	Logic; bodily kinaesthetic (3d s.); spatial/visual (drawn s.);	Visualise use in context	Needs visual and sequential construction skills
Technology immersion	Observe children using technology freely over a period of time	Exploration; Evaluation	(Druin, 1999)	–	Provides ideas on how children use technology, in a short period of time	Availability of technology

2.2.5 Mutual Benefits

A design team doing participatory design is considered as a community of practice of people with different expertise working together on a common goal (Druin, 1998; Good and Robertson, 2006; Sanders and Stappers, 2008). Therefore, an important feature of participatory design is the mutual learning exchanged amongst the participants involved. Many researchers (eg. Soloway, 1994; Kafai et al., 1996; Shneiderman, 1998; Druin, 1999) emphasise the multiple benefits of the involvement of users in design, both for the product design point of view and for the participants themselves. In this respect, while designers learn about the children's needs, behaviours and practices, the children have a rich learning experience, since the design activities can provide meaningful contexts for learning. The importance of creativity in educational contexts was also stressed by Robinson (2001) and formalised in UK by governmental initiatives to specifically develop creativity as part of the national curriculum as well as to include children's voices in decisions that affect them, as also suggested by other authors (e.g. Bragg, 2007; Department of Education, 2003; Woodcock, 2008).

Druin (1999) identified five main learning outcomes of working with children, that can be achieved by all members of the design team, namely: team working and collaboration, respect for design partners, technological skills, knowledge on the contents of the design topic and on the design process itself.

Another example taken from the literature on primary school children is the 'Kidstory' project, where a team of designers, researchers and children successfully worked together to develop innovative IT tools to support collaborative storytelling activities (Alborzi et al., 2000). The researchers conducted an evaluation consulting both teachers' and the children's own documentation of the sessions. The results showed that the whole design process was important to strengthen the children's identity as inventors, and, during the whole project, the pupils clearly improved their narrative skills as story-tellers and their understanding and handling of the supportive technology.

A particular context where this benefit is more noticeable is that of teenagers with behavioural problems, a user group not widely included in design studies. In general,

studies for both children and teenagers tend to consider mainstream children from mainstream environments. There are fewer studies of design activities with individuals that are on the edges of the educational system. An example is the work by Cavallo et al. (2004), where youth at risk were engaged in a learning project with technology. This work highlighted the effects of empowering pupils of their own learning, not only as regards their learning achievements but also their self-esteem and personal motivation. Another study is reported by Waraich and Wilson (2004), where an Informant Design approach is adopted to develop an interactive learning environment with pupils of a local Youth Service aged between 13 and 15. In this case the aim of the educational game was to teach management and business skills. The researchers claimed the success of the process for the engagement of the participants more than for the educational value of the product.

It has been debated in literature whether designers have to consider children as equal designers or not (Nesset and Large, 2004; Scaife and Rogers, 1998; Druin, 1998), but what is common to all approaches is that, in order to achieve an active participation of children in design activities, adult-child power structures need to be reconsidered so that children can feel at ease and feel empowered in their role of experts. Alborzi et al. (2000) suggested different ways to facilitate the equality of the partners, from playful activity to dressing and communication codes. Knudtzon et al. (2003) and Pardo et al. (2005) interestingly noted that when talking about technology, children do actually feel as, or even more, expert as adults, thus not feeling much affected by traditional power relations.

The framework produced by Lee and Bichard (2008) stressed the influence of the design practice in children and youth in their development of a sense of ownership and emancipation, reflected in one of the four stages of design participations, where the users gain awareness of their potential and at the same time develop creative thinking. Guha et al. (2010) also detected a general positive impact on children in their involvement as design partners as a side effect reported in many studies focussed on co-design practices. She therefore suggested formal methods to specifically study the consequences on children of their participation in the design process.

2.2.6 Understanding the children co-design practice

All co-design approaches, from informants to design partnership, require different degrees of effort to engage the children in a meaningful manner and transfer their contribution to design inputs. Similarly to co-design with adults, typical drawbacks for co-design practice with children are the costs in terms of time and resources in arranging, running and analysing the design sessions. When children are involved the following extra efforts are to be accounted for:

- gaining access to children – it requires making arrangements with parents, teachers and carers, dealing with strict ethical clearances, and fitting sessions into the children's school and extracurricular activities (Rode et al., 2003; Read and Mazzone, 2008);
- running the design session – whether in a school or in a lab space, it requires recruiting more than one researcher to facilitate the activities and guarantee a reasonable minimum adult/children ratio;
- after the session – after the session is completed, children's contributions are not easy to interpret and need to be filtered and analysed from different disciplines and perspectives before they can be considered inputs for the design (Ruland et al., 2008; Sluis-Thiescheffer et al., 2009; Mazzone et al., 2008a).

As it is already considered challenging to design with adult users (Kujala, 2008), this latter aspect of the process (interpretation) is often the one that deters many designers from undertaking co-design sessions with children. Children's contributions are considered mainly inspirational, so that concrete design ideas need to be iteratively processed by the designers before they can be turned into design inputs (Jones et al., 2003; Wyeth et al., 2006). Design projects usually have time and resource constraints that have to balance the effort spent with the pay back from the usability of the outputs. For this reason, much research is focussed on demonstrating the benefits of involving users in the design process and suggesting efficient ways to overcome the costs (Kujala, 2003; Nesset and Large, 2004; Sanders and Stappers, 2008; Steen et al., 2011).

One of the mostly acknowledged benefits a designer gets from working with children is the insight into their world, which helps to lead to requirements and design that are adequate for the user group (Williamson, 2003; Nesset and Large, 2004). Few studies have investigated how to evaluate the value of creative ideas (Hocevar, 1981; Amabile, 1982; Christiaans, 2002; Shah et al., 2003): creativity and appropriateness of the ideas are dimensions often mentioned in this respect. In the field of design with children Sluis-Thiescheffer et al. (2007) proposed a way to analyse design outputs of different design methods and therefore compare creative methods used in early design stages. They adjusted the Question-Option-Criteria method (MacLean et al., 1996) for interpreting children's contributions by letting children explain their ideas, to then code these ideas into design options and their success descriptors into criteria. By translating children's design ideas into design options and related criteria, they made possible that outputs from creative activities of different natures can be equally analysed and compared.

The need for guidance and directions for designers and researchers who want to organise and conduct meaningful participations has been also highlighted in a special issue of the 'CoDesign journal' (Woodcock, 2008). In this publication, many studies reported on the universally accepted value of including children in the early stages of any design and decision-making process but also highlighted the practical difficulties in involving children in a meaningful manner and ensuring their voice is included in the design process.

Good and Robertson (2006) identified the need for a model that fully captures the process of involving children and other relevant stakeholders. They claimed that existing models failed to take into account the process of design, or the different roles of the stakeholders, or the skills required by the design team members. They proposed a framework for designing learning environments (CARSS framework) based on five main components: contexts, activities, roles, stakeholders and skills. Although the framework they created is intended for the design of learning environments, its rationale and main components can be applied to the generic practice of involving children in design. The authors stressed the importance of defining clear roles amongst all the stakeholders, both valuing the inputs from children while at the same time appraising the knowledge and expertise of teachers or designers. Overall, the framework proved to be useful in defining the relevant

design parameters and constraint of design projects in order to determine a suitable level of child involvement.

2.3 Summary and Conclusions

This chapter analysed the nature of the co-design process, its pros and cons, and the existing research on design for and with children. This analysis contributes to building a deeper understanding of the practice of involving children in design, towards reaching the answer to RQ1 on how to break down the practice's complexity.

The conclusions drawn from the review of the research related to the field of interaction design and children are listed hereafter. I have numbered them with the identification LR (as for Literature Review) to refer to them in the rest of the thesis and show their influence in the development of the research.

LR1 – UCD and ID processes are not a unique and prescriptive set of steps. The principles they all share are: the importance of considering users' needs; the iteration of analysis, design and evaluation stages; and the involvement of users in the process

LR2 – Co-design is a useful practice to get users' real insights and design more user-centred product but relies on designers ability to conduct the studies and analyse the results

LR3 – Developmental stages are not the only critical factors to take into account when designing for and with children. Although age is the most straightforward way to distinguish user groups, there are other variables (e.g. social context, community of practice) that influence children's capability to interact with technology and to participate in co-design sessions

LR4 – Most researchers advocate a balance between activities with children and reflections and analysis of designers in the overall design process – as in informant design

LR5 – There is a huge range of techniques applied in design projects. These techniques come from established methods and are adjusted, adapted and modified in each design instance

LR6 – There are a variety of roles and competencies for the different participants in co-design sessions with children that have to be clearly defined.

3 CHAPTER THREE: CASE STUDIES

In this chapter I describe the research projects in which I have applied co-design practice with children and that have helped me to build expertise in the field. The lessons learnt from each project served to reinforce my knowledge on the different elements that belong in co-design sessions and therefore contribute towards answering RQ2 on identifying elements that are relevant in co-design sessions.

Hereafter I will report in detail the research studies of two one-year projects ('BEAM' and 'COOL', Sections 3.1 and 3.2) and the first year of a three-year project ('UMSIC', Section 3.3) that represent the body of direct experience in the field of involving children in design. Each project contributed to building knowledge on the practice of co-design and the role of the different aspects involved in it. For each project I first provide a brief description, with the project's setting, objectives and constraints before reporting on the design activities and their results, and then concluding with reflections of the lessons learnt on aspects of running co-design sessions. These lessons are listed at the end of each project's section and numbered according to the initial of the project (B=BEAM, C=COOL, U=UMSIC).

In all the studies children were engaged in defined design activities over a predetermined amount of time, therefore considered more as informants (Scaife et al., 1997) rather than design partners. All of these projects relied on the cooperation of one or more research teams, hereafter detailed in each of the 'project settings' sections. Although design decisions were taken jointly in the project team, my specific role in the projects has been to take charge of design activities: from defining the tasks to arranging the sessions beforehand; during the design session to act as a facilitator, providing the children with instructions and resources for the design activities; and finally, in the analysis of the results, proposing keys to interpretation for the design.

At the beginning of my research in this field, I conducted a series of pilot studies of design sessions with children as single instances, each with a specific design aim, context, and children age (all between 5 and 11 years old). These initial studies, considered as design exercises, helped understand the different practices of the methods and their effectiveness, and provided the knowledge basis for the subsequent research projects.

3.1 The BEAM Project

The first project that allowed a study on co-design practice over a period of twelve months is the BEAM Project, funded by the Lancashire Digital Development Agency (UK) to promote the use of broadband technology to support educational activities. BEAM stands for Broadband Enabled Activities for Museums and it intended to exploit the potential of broadband technologies in providing direct connection between schools and museums so to enhance learning related to the visit to the museum. According to this aim, the project was designed to assist the students' learning experience throughout the three stages of before, during and after the museum visit. Specific technology was required to support the children during each stage by allowing them to:

Pre-visit. Access the project website and explore the physical space via webcams positioned in the museum; register the school visit and plan the visit selecting the curriculum related topics and the supportive technology available on site;

During visit. Record the experience by taking pictures, writing notes or recording comments with digital equipment such as cameras, PDAs, tablet PCs, Dictaphones;

Post-visit. Log in to the secure personal account created for the specific school visit to access all the rich media files produced during the visit and use them for class activities.

3.1.1 The Project Settings

3.1.1.1 The Research Team

The research team comprised an interaction designer (me) expert in user centred design methods, and two web designers, experts in HCI and usability issues. Every design decision was agreed in the team, and each member took a leading role in each stage of the project related to his or her expertise.

3.1.1.2 The Participants

The target user group comprised primary school children (aged 5-11) and teachers. Different local schools were selected for participation in the design and evaluation cycles over the duration of the projects. Museum curators were also regularly consulted for user requirements as well as for technical and administrative issues

concerning the management of the database and the installation of webcams in museums.

3.1.1.3 The Constraints

Defined technologies to be included. The project required the use of broadband and digital technology.

Defined time. As with most funded projects, the BEAM project had already defined time duration and milestones to be met within the time span.

Technical and administrative restrictions. These were related to the server connectivity, the security access to museums, connections between museums and schools via secure networks.

3.1.2 Design Objectives

One of the main aims was to provide the children with a coherent experience by designing suitable interactions with a range of digital products. The two technologies that required designing of specific interfaces were the website and the tablet PC and an Informant Design approach was adopted to gather design ideas for the interaction with these devices. The children's contribution was sought for in the following aspects:

Terminology. Achieve a better understanding of their knowledge of terms related to the museum's topic;

Children's experience. Discover the children's perceptions and experience of the museum context;

Familiarity with content visualisation. Understand children's familiarity with the concept of visualisation of contents and information;

Understanding of technology interaction. Ascertain children's understanding of interacting with technology.

3.1.3 Design Activities

The design process was conceived as a combination of different design activities with and without children, as defined in the Bluebells method (Kelly et al., 2006). Design sessions that included children were alternated with designers' only analysis

and implementation of children's ideas. A detailed description of the different methods used throughout the project is reported in Kelly et al. (2006). In the context of this thesis the focus is on the design activities of a single design session with children and the approach to the analysis of the resulting data. In the BEAM project, the results from this first session were then used as a starting point of the following session, and so on until their implementation in the first digital prototype had been evaluated.

The two specific design activities aimed at exploring the contents and interaction of the website. The activities took place in the classrooms, with the teacher and at least one teaching assistant present in each class together with the two researchers leading the design session. Two classes of Year 3 children (aged 7 and 8) from the same school were engaged in the one-hour activities, one class immediately after the other. A total of 42 children participated in the design sessions with the two researchers. Before starting the activities, the children had to be introduced to the context via images and narratives of the museum they were referring to. In the first activity of the design session the children were asked to produce lists of words that they might associate with the application. In the second activity, the children were shown a wire-frame interactive prototype of the product and given blank paper artefacts on which they were asked to add content. With this practice the design team sought insights into the children's perceptions of the context, their knowledge, their preferences, the terms they were familiar with and the topics that were relevant to them.

3.1.3.1 Activity 1: 'Thought Shower' With Post-it Notes

The first activity was a brainstorming exercise to help children to get into the topic and retrieve information from their previous experience and background knowledge. Children split into groups of three to five pupils around each table. They were asked to write or draw on post-it notes all the concepts related to their memories of their recent visit to Helmshore Museum (UK), a local textile museum: what they had seen, what they had learnt, what they liked about it. All the notes were then collected and grouped according to similarities of topic for each table. Clustering them in this way gave an idea of categories of topic that were relevant for them.

3.1.3.2 Activity 2: Creating Page Content With 'Boxes' and 'Buttons'

The aim of this design activity was to get an idea of the children's concept of navigation, their perception of how to organise text, pictures, sound and interaction in the interface. Sitting around the same tables as in the previous activity, the children then started to prototype pages with the content and activities that could happen on the tablet PC. Figure 3.1 depicts a moment of activity 2: the output of the first activity was kept in the middle of the table with all the post-it notes stuck on an A3 sheet and used as a reminder of information.

Figure 3.1 Children creating contents for the interface.

The children were provided with A3 sheets of paper on which they could stick paper 'action buttons' or 'content boxes' and write and draw with coloured felt tip pens. For this activity they were provided with a set of types of contents and four types of buttons that represented possible information and actions to include in the interactivity of the technology. The selection of these objects was based on possible educational activities related to the museum visit and the information that would derive from it. The four possible types of content related to the different ways of showing information, whether it was written, visual, audio or multimedia. These were squared cut pieces of paper with a faded image representing the nature of the information a well as a short caption underneath:

Text: "Here you can put some text, what will it be about?"

Picture: “Here is a picture, what will it be?”

Sound: “Here is some sound/voice, what will it be like?”

Video: “Here is a video, what will it show?”

The other class of prompts concerned actions. As they intended to be simple prompts for interactivity and leave space for creativity they were kept quite generic. The ‘buttons’ were round shaped paper cut-outs, all of the same size, with little icons representing the different types of actions:

Links: “Press me and I’ll take you to…”

Doing: “Press me and I’ll let you do…”

Writing: “Press me and I’ll let you write…”

Cut and paste: “Press me and I’ll let you stick…”

The children were instructed to write or draw additional information to explain what they wanted to include. Because of the low designer–children ratio in each session, writing was particularly encouraged in order not to lose much information from possible misinterpretation of the results in the post-session analysis. For the same reason each group gave a short presentation of their output at the end of the session, as seen in Figure 3.2.

Figure 3.2 Children presenting their work at the end of the session

3.1.4 Analysis of the Outcomes

The outcome of the design sessions was a conspicuous amount of drawings and writing on paper and sticky notes that needed to be analysed to gather information to feed the future design. When it came to analyse the information collected from the activities particular attention was paid to the way the data were produced, i.e. the groups of children in which the information was produced and the instructions and the materials provided for each activity. Each of the activities was analysed in a different way according to the nature of the data collected as described below.

What came out from Activity 1 was an insight into the children's perception about the museum whilst Activity 2 provided a broad understanding of topics that were of interest to the children. They also provided original ideas for activities and contents to be included in the future product.

3.1.4.1 Analysing Activity 1: Thought Shower With Post-it Notes

All the notes produced by the children in each group were attached to the same A3 sheet, for a total of 10 groups. All the contents written or drawn in each group were listed and six main categories were identified from the information gathered from the children's output. Table 3.1 shows the number of notes produced by each group (A

to L) for each category of contents; the most popular category in each group is highlighted in grey.

Table 3.1 Number of post-it notes on the same topic for each group in Activity 1

	Groups										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**L**	**Tot**
Water Wheel	4	5	4	4	6	3	4	4	4	4	42
Machines	2	1	5	-	3	4	4	4	8	3	34
Textile Tools	-	1	3	3	-	1	3	2	4	3	20
Museum Gallery	1	-	3	3	-	4	-	2	2	1	16
Physical Space	5	6	4	1	-	-	-	-	-	-	16
Museum History	-	1	1	-	-	-	-	3	-	-	5

Although the children had last visited the museum several months before the design activity, they clearly remembered general ideas as well as some details and names and managed to produce a varied amount of information. Clustering the outcomes by groups (see Table 3.1) showed that all the groups had one or two categories as the most popular and some other category as unique to each group. It was important to analyse the results dividing them into groups rather than just looking the grand total of the information produced by the children in order to note this behaviour. It is likely that it was mainly due to the children sitting around the same table and getting inspired by each other's memories. Copying from group mates is a well-established behaviour in group activities (Sluis-Thiescheffer et al., 2007; Kuure et al., 2010). In this case it helped generate a larger amount of ideas but limited the variety within the group.

3.1.4.2 Analysing Activity 2: Creating Page Content with 'Boxes' and 'Buttons'

For the second activity, although the children were in the same groups as in the first activity, they tended to work on their own interface, with only four children working in pairs. In this activity the children enjoyed producing a considerable number of contents and ideas. For each interface a count was made of how many of each type of content (sound, video, pictures, text) and of interaction (writing, links, actions, pasting) the children included from the ones provided. The diagrams in Figure 3.3

and Figure 3.4 show how many of each type of object were included in the total of the interfaces (light coloured columns) and how much additional information was attached to each type (dark coloured columns).

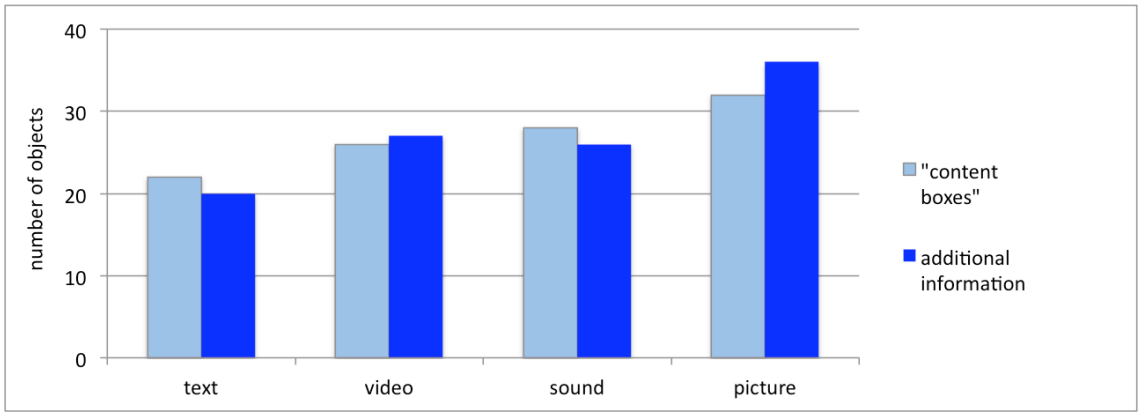


Figure 3.3 Diagram of the number of 'content boxes' included in the interfaces and the related additional information

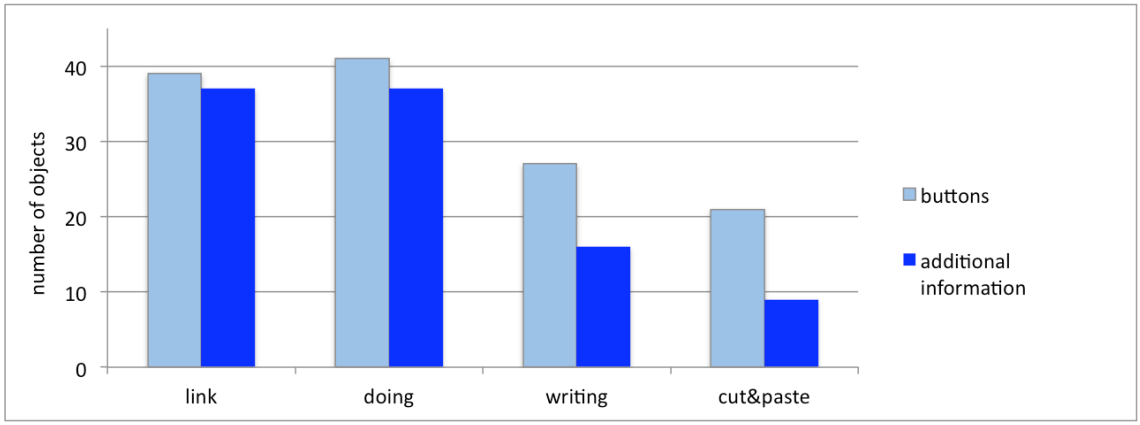


Figure 3.4 Diagram of the number of 'buttons' included in the interfaces and the related additional information

With regards to the 'boxes' type of objects, all the four types were used in all the interfaces in a similar amount. From the diagram it can be noted that the most popular ones were the pictures and the video 'boxes', where the children added a higher amount of information, more than one per object. In a different way, for the 'buttons' there was a difference between the amount of 'link' and 'doing' types used and the 'writing' and 'cut and paste' types. Also, the 'cut and paste' type had the lowest amount of information added per item: more than half of the objects were not accompanied by information added from the children, while the average rate was close to one. Apart from being actions that the children were not particularly

interested in, the little use can be related to the design and description of the buttons themselves that were unclear to the children.

To understand the children's use of the tools provided for the design, particular attention was paid to the information added, by writing or drawing, to each 'boxes', 'button' or directly on the sheet of paper that stood for the background. In some cases, the faded pictures in the background of the 'content boxes' notes used as prompts have been a possible cause of ambiguity and confusion. Although they did not bias the final results, they might have been the cause of the fact that most of the children added writing to the 'content boxes' but not many drawings. Children used the space on the background paper to freely draw decorations to the page as well as information related to the contents. The fact that some children did not complete the sentences on the stickers, nor annotate them with drawing or writing, led us to assume that the function of the specific design tool was not clear to all of them.

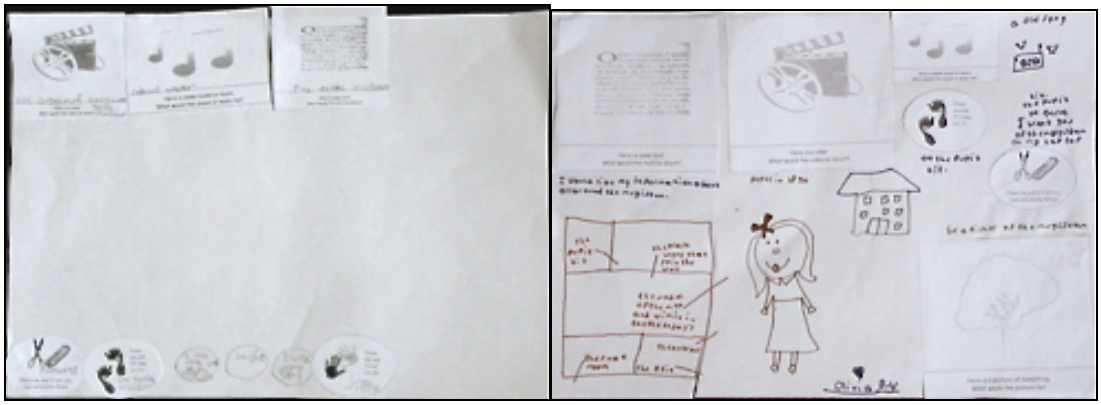


Figure 3.5 Examples of different children's outputs for Activity 2

What was also noted, as can be seen in Figure 3.5, is that the way children used the space and the material provided for the design varied considerably.

3.1.5 Reflections on the BEAM Project Design Case

The large number of children that participated in the activity produced a considerable amount of data in a short time. This output prompted the need for a thorough interpretation of the information collected rather than just an inspirational understanding of children perceptions and interests. Many studies, especially the ones adopting a design partnership approach with young users (Druin, 1999; Guha et al. 2004) have a high adult–child ratio: this is to facilitate the adult's understanding

and interpretation of the children's contribution. For the BEAM study the ratio was particularly low: although the number of available researchers for the session was limited it was decided to involve the whole classroom because the research followed an inclusive approach and was not seeking to select only a few students. In this way, due to the project time constraints, it was also possible to collect a large amount of information in a limited period of time. This decision was feasible for this case due to the nature of the information that was sought in this specific study: to reach an understanding of children's memories and perceptions of the museum visit, quantity of information had priority over depth of details. One of the major problems faced when trying to collate and analyse such a varied collection of data is that the children are very likely to spend time reinforcing behaviours (i.e. repeating key words as seen in the results of Activity 1, Section 3.1.4.1). In addition, Activity 2 demonstrated that, despite growing up in a technological world, the children were still not familiar with many common user interface elements (e.g. buttons and windows, or navigation flow) and require more grounding in their meaning if they are to contribute more directly to useful designs.

The analysis of the outputs produced during the session not only provided useful information for the design of the future product but also highlighted issues about the methods and tools used during the activities. When deciding the way to analyse outcomes from an activity it is important to ponder the way the outcomes were produced. For Activity 1, for example, the thought shower proved to be an effective way to trigger children's memories by facilitating different modes of expression in a short time. At the same time the variety and quantity of the information produced depended on the group the children were in. In this case it was not considered to have a negative effect, but it flagged the influence of the settings in analysing results (Mazzone et al., 2008a). For Activity 2, the methods and the materials used resulted in being appropriate shortcuts for the children to produce a large amount of information but they needed further improvements in the way the 'boxes' and 'buttons' are represented to increase the ease of use from the children. The effects that the selected methods and the available settings had on the results stressed the importance of detailed planning. A clear distinction of the design session in before, during and after moments served to identify the resources available at each stage and how to optimise them according to the design aim (Kelly et al., 2006). Having the

children present their work at the end of the session served to get a sense of the activity's outcome, especially because the researchers could not follow all the children's work closely.

To summarise, the major findings from this co-design experience towards an understanding of the co-design practice were:

B1 – Inclusive approach (i.e. whole classroom) implied adjusting strategies (i.e. quantity vs. detailed information) to available resources (i.e. few facilitators per large number of children)

B2 – The way date were generated (i.e. within groups, prompts used) affected the way they have to be analysed

B3 – Working in groups triggered ideas but also repeated information

B4 – Clear distinction of before, during, after moments helped to identify resources and requirements for the whole process

B5 – Closing the activity with a presentation (group or individual) gave researchers an understanding of the outcomes and children a sense of completion.

3.2 The COOL Project

This project was a joint project funded by the HEFCE's Strategic Development Urban Regeneration Fund (UK). It was led by a team of psychologists and supported by designers and interaction developers. The goal of this one-year research project was to deliver an educational computer game to teach pupils with difficult behaviour to deal with their emotions. Involving groups of potential end users in the design process of the game as main informants was considered necessary to achieve a product meant to reach the target. Based on the four areas of Emotional Intelligence (EI) as identified in Mayer et al. (2000) and Salovey et al. (2004), the topics of the game were divided into four sections as follows:

Labelling emotions – An awareness of one's own and others' emotions, monitoring, and ability to recognise them appropriately;

Understanding emotions – Why certain emotions arise in certain situations and how different emotions relate to one another;

Using emotions – Use of emotions to facilitate thought and guide behaviour; ability to see and also adopt different perspectives;

Managing emotions – Ability to regulate emotions, knowing how to control a situation that may lead to anger or anxiety.

Hereafter I report the involvement of the children in the design activities at the early stages of the project (for a more complete view of the entire process, please refer to Mazzone et al. (2008b)).

3.2.1 The Project Settings

3.2.1.1 The Research Team

The design team comprised two researchers experienced in designing interactive products with children and teenagers (technology group) and two psychologists (psychology group) who were experienced in working with pupils with attention difficulties but did not have experience in participatory design. At any one session, a combination of at least three members of the team attended.

3.2.1.2 The Participants

Five groups of pupils were selected to take part in the design sessions. The two core user groups were teenagers from two local Pupil Referral Units (PRUs): this group was a total of 17 individuals, aged between 13 and 16 years old. They represented the core user group to design for. The PRUs operate in a similar way to mainstream schools but are attended by pupils considered unable to deal with mainstream education. These pupils typically have a short attention span, low motivation, disruptive behaviour, and unpredictable attendance.

Recruiting participants from these PRUs was difficult as each unit has a different management policy and not all units could easily adapt to ad hoc design sessions. For this reason, it was decided to also carry out the same design activities with three classes of similar age teenagers from a local (mainstream) secondary school. The choice of including the non-core user group in the design phase allowed collecting a richer amount of data with regards to the age group whilst also enabling the design

team to realise the similarities and differences of pupils from the two types of learning environment. All the design sessions were conducted in allocated spaces in the school environment. This was generally a classroom or a hall and, in each instance, a teacher was present during the activities to oversee the pupils engaging in the tasks.

3.2.1.3 The Constraints

Defined contents. The contents of the computer game were already structured in four sections (corresponding to the four EI areas mentioned above), and a list of specific activities to include was in place before the design activities began. This limited the variety of the pupils' contributions, but on the other hand it helped the focus of the design sessions.

Defined time. Due to the different school calendars and availabilities, a predetermined amount of meetings was scheduled since the beginning of the project and little flexibility was allowed.

Unpredictable availability of the participants. In the PRUs, the pupils and the school system were unpredictable. Sometimes the design sessions were cancelled just a few hours before their scheduled time because of some emergent disruptive situation that needed priority. Thus some sessions needed to be skipped and not all the design aspects planned for the project could be explored.

3.2.2 Design Objectives

As specified earlier, the aim of the project was to implement an educational game on emotional intelligence, whose content and structure were defined by the group of psychologists. The game was required to include specific activities on the four areas of emotions (Mayers et al., 2000) as well as to provide a detailed definition and explanation of a core set of emotions. The psychologists identified the ten core emotions the game would have focussed on and they decided those were the ones the pupils should get familiar with.

Prior to the design sessions, the psychology team collected information about the pupils and their specific context from the tutors. Considering the user group as expert on their context, what needed to be identified was the type of information that was

feasible to collect during the design sessions with the pupils. The key features to focus and get information on were:

Vocabulary. Understanding of specific terms and language the pupils are familiar with. This is of particular importance as it could not be simply elicited from standard National Curriculum level or age development skills.

Abilities. Knowledge of the specific skills and abilities of the user groups. As assumptions could not be made simply from age and grade, we needed to gather information about their literacy and computing skills together with the comprehension of their learning difficulties and attention span.

Interests. Awareness of particular topics that will catch the interest and attention of the users. These topics can relate to public life situations or characters, but also their personal hobbies and habits. As the product involved reflection on emotions and behaviour, it was particularly important to understand the pupils' attitude towards talking about their personal life.

Familiar contexts. Insights on the particular situations that they feel at ease to talk about as well as the ones to avoid. These situations regard aspects of both their social and private life, as for example at school, with friends or at home.

3.2.3 Design Activities

To gather information on the identified key aspects, the design sessions focussed around four main activities: defining a scoring system of the game; creating scenarios, naming emotions; and drawing of facial expression of emotions. Working on these tasks allowed for collecting specific design ideas but also gaining a generic understanding of pupils' contexts together with knowledge on the identified key features for the design, relating to the values, the vocabulary, the interests, and the abilities of the pupils.

3.2.3.1 Activity 1: The Scoring System

Games rely on the player being engaged in achieving a goal and a common method used to keep motivation and interest is to allow players to gain points and move through levels. This component encourages interactivity and provides some level of challenge. Including a scoring system in the game was a non-confrontational design aspect that could be discussed in early design sessions. Previous work (Robertson

and Nicholson, 2007) had shown that teenagers needed a prompt for designing; therefore, in this activity the teenagers were presented with a recent celebrity story about famous couples from the news who were having relationship difficulties. The pupils had then to create a paper comic strip that showed the interplay between these two characters and to suggest different endings, depending on which 'points' could be scored. This activity gave the participants a chance to reflect on positive and negative scoring for actions, without these actions being related to their own situations.

3.2.3.2 Activity 2: Creating Scenarios and Conversations

Part of the activities to perform during the game refers to everyday life situations the pupils are likely to find themselves in. This specific design activity was aimed at both understanding their everyday language and also the type of situations they were more familiar with. The pupils were asked to draw a short storyboard to tell a story of a typical situation in their daily life. They were provided with information on how a storyboard works and prompted with a range of different contexts they could refer to. Pupils worked either individually or in small groups.

They then had to make short animations of their scenarios, like stop-motion animations, with the use of plasticine, cardboard, coloured pens and digital cameras. The language was included after the 'movie' and was made by adding speech bubbles. Most of the participants did not have time to get to the final task of assembling the pictures on the computer, but the dialogues were captured in the storyboard.

3.2.3.3 Activity 3: Labelling Facial Expressions

The labelling activity used popular media as a prop. The aim of this activity was to get pupils' interpretation of the emotions. The pupils were given recent newspapers and asked to select several pictures of people's faces. They had then to add words to them, showing their understanding of these people's feelings, what they might be thinking, and what emotion might be associated to their facial expression. Following this, pupils were shown a list of smiley faces with different expressions on a white sheet of paper and were asked to recognise and label the corresponding emotions.

3.2.3.4 Activity 4: Drawing Faces of Specific Emotions

Since the general goal of the computer game that was being designed was for pupils to understand and manage emotions, it was important to know how the pupils would picture the different expressions around the ten core emotions. The children had to draw the facial expression representing each of the selected emotions on paper. With the intention of injecting some fun and entertainment, the same kind of activity was repeated using round flat biscuits and icing pens. The pupils had the chance to take a picture of their drawings of the smiley faces appropriate to the named emotions before eating them.

3.2.4 Analysis of the Outcomes

Due to the nature of the project and the little flexibility of its content, the information collected from the design activities was primarily analysed from the psychologists' point of view and then its implication for the design of the game was negotiated with the design partners. For the design point of view, the data collected in each of the design sessions were analysed against the four key features identified beforehand, i.e. vocabulary, interests, abilities, and contexts.

3.2.4.1 Analysing Activity 1: The Scoring System

From the point of view of the contribution to the final design, little useful information was elicited about scoring methods but some useful language was gathered. The main role of this first design activity was also to explore an unknown territory for the researchers, which was to work with non-mainstream school groups of children. It was therefore important to get to know the way of working of this user group and break the ice and catch participants' interest as a positive basis for participation in the activities to follow. At the same time, involving the pupils in defining what they considered a reward or punishment gave the designers some insights on the system of values.

3.2.4.2 Analysing Activity 2: Creating Scenarios and Conversations

Letting pupils create situations worked quite well and the attention to details in some of the scenarios was a surprise. The difference in the engagement on these activities depended widely on the personality of the child. Some of them were really engaged in creating an original and meaningful story, while others were more uninvolved and bored.

Figure 3.6 A scenario created with plasticine, photographed and edited by one of the pupils

Most of the stories had some violence features and a bad ending (an example is shown in Figure 3.6, where a boy is shooting a girl in front of a shop), providing insights on familiar contexts and language to take into account when setting stories for the games.

3.2.4.3 Analysing Activity 3: Labelling Facial Expressions

This activity of labelling emotions proved that the language of emotions is both complex and 'fine grained'. What was most useful from this activity was the understanding of the vocabulary of the participants to describe their emotions. Most of the participants had only a small vocabulary to recognise and describe emotions – especially for the subtlest ones, not as common as 'sad' or 'happy', as could be the case of 'proud' or 'guilty'. This finding implied special attention and emphasis should be put on explaining and representing these emotions in the game by using terms that were more familiar to the young people.

3.2.4.4 Analysing Activity 4: Drawing Faces of Specific Emotions

Both instances of the activity, on paper and on biscuits, gave useful information about how the pupils understand the emotions and represent them.

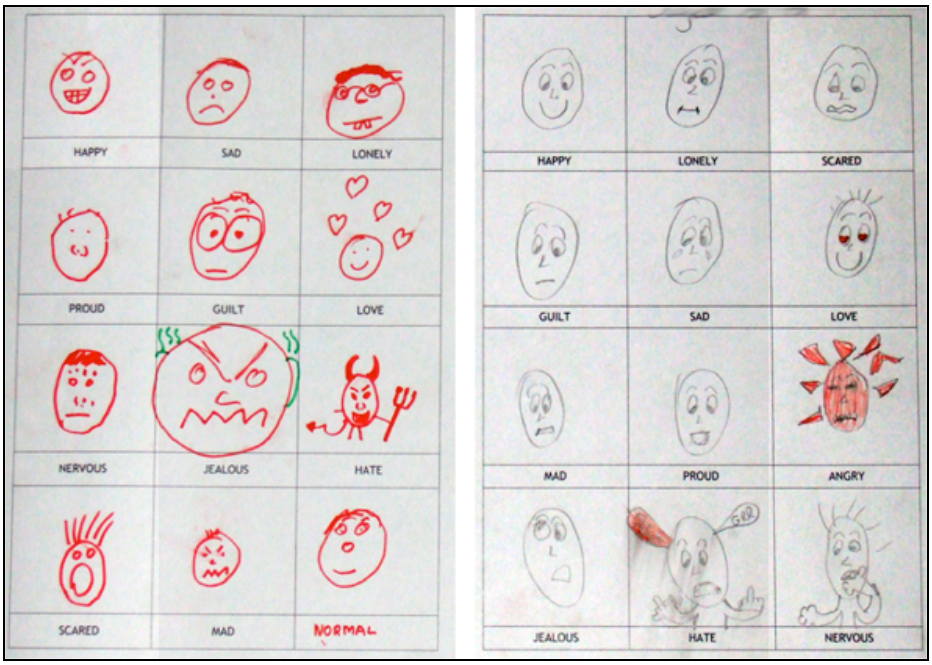


Figure 3.7 Examples of pupils' drawing of emotions

Some children used additional external elements to emphasise the facial expression of the emotions (i.e. hearts for the 'love' emotion and 'devil's horns' or lightning bolt for the 'mad' emotion) – as can be seen in Figure 3.7.

3.2.5 Reflections on the Cool Project Design Case

The design activities were planned to gather useful information from the design point of view but at the same time they also provided insights on the participants' different learning styles and abilities. Every person has a preferred learning style depending on his/her strength in different abilities, from linguistic to logical, from spatial to interpersonal and kinaesthetic or intrapersonal (as in Gardner (1993)'s multiple intelligences theory). For this purpose, different forms of expression were used: from handling plasticine to taking digital pictures of their works, from acting out scenarios to video recording their own performance, from board games to decorating cookies.

The variety of the activities employed in the COOL project proved to be valuable for the pupils in many different ways, whether enjoying being three-dimensional artists or film-makers or finding a talent for handling craft. It was observed that over the five-week sessions of the study the level of engagement in the activities remarkably increased for many of the participants. This observation was asserted by the tutors who knew the pupils and used to work with them prior to the project and was also

confirmed by an informal questionnaire handed to the pupils where they assessed their perception of involvement and contribution to the project. The results of the design sessions were therefore positive, not only for the contributions to the design from first hand insights, but also from the pupils' and from the case workers' point of view. The idea of contributing to a computer game and also the fact of being acknowledged for it engaged the pupils by giving them some sort of responsibility. The tutors and case workers recognized that having used varied types of activities had been successful with the pupils. These aspects were reflected in an improving behaviour over the design sessions and a progressive engagement in the activities.

What also emerged from this project is the importance of the context and cultural background in the successful employment of different methods. For example, students of the same age from mainstream schools, when asked to represent scenarios with plasticine, showed less engagement than the participants in PRUs. Although its reason was not investigated in the project, one possible explanation can be due to pupils' experiences and habits of play and entertainment. In this case, what they considered interesting and engaging did not depend on the age but on their social and cultural contexts.

The design sessions of this project contributed not only to the design of the game but also to expand expertise and knowledge for the research team on the co-design practice. The fact of having a multidisciplinary research team with different approaches to the participatory sessions and different priorities highlighted the importance of a thorough preparation before the design session. Getting access to users was often difficult, therefore the research team wanted to make the most out of every session – this intention resulting sometimes, especially at the beginning, in mismatching conduct of the different facilitators. While from a design point of view children were encouraged to express their creativity and knowledge on the topics, from a psychology point of view they were questioned on the appropriateness of their answers related to feelings. Although it may be considered an obvious caveat, coordination amongst facilitators needs to be clearly defined and consented on beforehand. Disregard of an agreed understanding of the facilitators' role may lead to confusion during the session, i.e., misunderstanding of the goals or of the activities, facilitators influencing children's performance and biasing the outputs of the session.

Another aspect that was particularly emphasised in this project was the occurrence of unexpected situations during the design sessions. Both due to the nature of the PRUs and the unpredictability of the participants' behaviour (e.g. some depending on medication) it was important to be prepared to handle change of time, duration, and location for the activities once the session has already started. The possible consequences of these incidences on the design sessions were mitigated by having a range of alternative activities that required varying time and level of concentration required. These back-up activities served to adapt to situations in which the participants were getting distracted, the location was more or less noisy or spacious, or the duration of the session was discontinuous.

Findings from this co-design experience (C – for COOL project) can be summarised as:

C1 – Using a variety of communication channels allowed children of different intelligences/abilities to express themselves

C2 – Having an open mind towards the outcomes of the design sessions allowed the researchers to embrace novel and unexpected results potentially different from the ones initially sought for

C3 – Benefits for the children (e.g. entertainment, educational, personal) were positive extras that contributed to increase the participants' engagement

C4 – The multidisciplinarity of the teams meant having different approaches to the design sessions, thus demanding a more thorough preparation and explicitness of aims and focus

C5 – Cultural and social backgrounds of participants affected the suitability of the design activities more than age

C6 – The unpredictability of the sessions and participants conditions required to having activities with different formats to adapt to the changing situations.

3.3 The UMSIC Project

The UMSIC project is a three-year European Union funded research project (FP7-ICT-2008-224561), involving research institutions and Information Technology

companies from five different countries. The project aimed to develop a mobile system that encourages creative music making and music sharing among children. The project's target user groups were preschool (aged 3-6) and school-aged (6-12) children. The final product was expected to be a mobile music application that provides sound sampling and touch-screen virtual musical instruments in an educative form for children by enabling composition, instrument playing with improvisation, and singing with vocal improvisation. The research reported in this thesis belongs to the early stages of the project, exploring different possibilities of implementing and presenting the music activities in suitable ways for children.

3.3.1 The Project Settings

3.3.1.1 The Research Team

In order to design the music application, the project joined experts in interaction design, music education and pedagogy. These experts set some of the initial requirements and produced initial design concepts, while two specific research teams were involved in the co-design sessions with children and located in two different countries: England and Finland. Both local university research groups engaged in the studies had backgrounds in HCI research, but differed in specialisations: while the English group had more expertise in children's technology design and evaluation, the Finnish group had HCI and programming expertise for adult users' technologies and specific expertise in music technology and education. The English team I belonged to was in charge of setting the design studies and shared their expertise and know-how with the Finnish team. I have been the person responsible for this knowledge transfer between the groups, first in a joint study in Finland and then remotely mentoring the Finnish design studies afterwards.

3.3.1.2 The Participants

The different studies described in this section were carried out over one academic year (from autumn to spring); the first sessions took place in different primary schools in England, with two Year 5 classes (age 9-10) and one Year 2 class (age 6-7), conducted by the English research team that was expert in participatory design with children; the joint study, where the English and Finnish research groups worked together to share a common understanding of the design practice, was set in an International Primary School in Finland, with a class of 14 children aged 8.

3.3.1.3 The Constraints

Project schedule. Being a 3-year project it had more time availability compared to the two previously described projects and allowed the researchers to build established partnerships with schools that would provide access to different classes throughout the three years. Nevertheless, it had strict timeline and specific project objectives to meet on time in order to guarantee the European funding.

Defined technical device. As the objective of the project was to design mobile music games for children, the technical support was decided since the beginning of the project to be a mobile touch screen Nokia N900 device.

Distributed design teams. Being a European project, the research teams were located in different countries, each team having a specific role in the project. The group in England had experts in design and evaluation children's technology, the group in Finland had experts in HCI, music technology and education.

3.3.2 Design Objectives

In the early studies of the project children were involved so that the research team could build its understandings of children's preferences related to music devices and applications. There were several unresolved issues related to both the functionality and the usability of the application, and so the intervention of the children was needed to both gain a first hand insight of the users and clarify specific issues related to the music application. Therefore, the main objectives of the co-design sessions are listed as follows:

Perception of music players. Understand children's perception of music players and music playing.

Initial design concept. Validate the initial design ideas and requirements produced by music educators at the beginning of the project.

Concept generation. Produce additional new ideas from children's perspectives.

3.3.3 Design Activities

The design sessions were organized in the locations of the two research teams, England and Finland, allowing slight modifications of the sessions. Each session was modified according to the lessons learned in the process, as well as adapted to the

particular settings of the sessions (i.e. the age and language of the groups of children involved). Each single design session was made up of three different design activities. Every design activity had a specific design focus related to the project design objectives and was intended to either get a deeper understanding of the design context - children's perception of music playing – or aimed at investigating specific design requirements. Before each session the researchers agreed on the briefing of the activities and discussed their suitability for the children with the teachers. The preparation included the provision of the tools to use and the assignment of the facilitators' roles to guarantee a smooth flow of the sessions.

In the following sections I give an overview of the three primary activities of the design sessions I participated in (namely, the studies in England, with three different school classes, with children from 6 to 10, and the joint study in Finland, with 14 children aged 7 and 8). In the context of this thesis, the description of the activities and its findings provided hereafter does not specify the different instances of the sessions and the locations as it serves as the basis for discussing the general findings and lessons learnt from this project on the co-design practice. A detailed description of the activities with regards to the project development can be found in Mazzone et al. (2010).

3.3.3.1 Activity 1: "The Magic Music Toy"

The aims of this activity were to understand children's concepts of music playing, elicit their ideas of a music toy, and discover how they liked to play with a music application.

To start off this activity, a video was shown to help children understand the object of their activity. The video showed two boys talking with one another about a new music gadget. The gadget is not seen in the video, showing only the two boys' conversation and evidence that they are playing with a portable device (see Figure 3.8). This method is adapted from Briggs and Olivier (2008) and further reported in Read et al. (2010) where it is described as Obstructed Theatre. The method intends to trigger design ideas without biasing the viewers' imagination by showing a real object.

Figure 3.8 A screenshot from the trigger video: two boys playing with the unseen music device

After the two-minute video, the researchers asked the children to think about what the mysterious device could do and what it would look like. No functional constraints were given in this activity: the children were free to imagine any sort of behaviour related to music and were encouraged to convey their ideas by drawing on blank sheets of paper and by representing their ideas with art and craft materials. Generally, children were very active and immediately started creating. In addition to the video, inspiration came to the children both from talking with the researchers and watching or working with classmates. Children kept adding and changing their initial design over the time, as they thought of different ideas, found different materials to use, or as they encountered practical problems in implementing 3D versions of their original designs. A pair of children decided to work together, and some children ended up playing each other's instruments. The younger children (age 6-7) needed more time and explanation to get started, and a facilitator sitting with them all the time to prompt their work.

3.3.3.2 Activity 2: "If I Were There I Would Play This"

This activity aimed to test one of the initial design ideas of the music education experts for the music application, where different kinds of music are associated with different places or environments. In the product to design, these associations were intended to help structure the organisation of music files by relating files to specific sceneries. In the design sessions the specific aim was to capture what type of instruments children of these ages are more familiar with or fond of, while investigating the level of association children make between music and places. The children were asked to draw their favourite instruments and then also draw places or

locations with which they would associate the instruments. To validate the idea of the place-instruments relation suggested in the project requirements, a variation of the activity was added: children were shown three different landscapes and then asked to draw or write instruments that they would associate each landscape with. The three landscapes used for this activity were the three scenarios defined by the music experts in the initial design concepts for the music application: a jungle, a city and a castle – as shown in Figure 3.9.

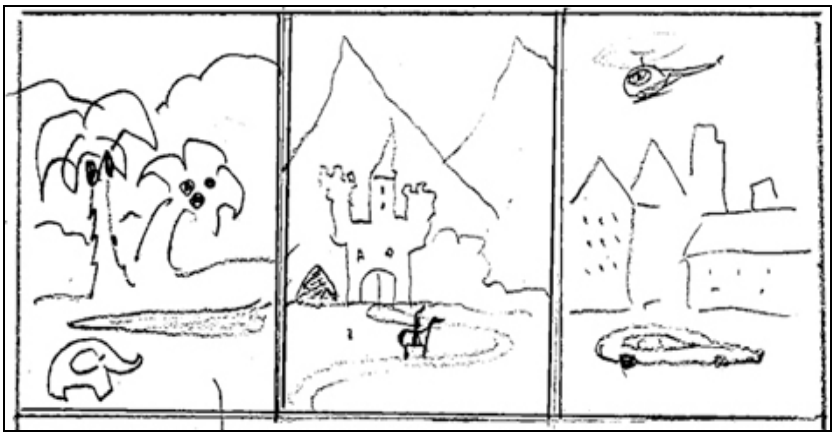


Figure 3.9 The three landscapes for the music application (a natural landscape: the jungle, a fantasy one: the castle, an urban one: the city)

3.3.3.3 Activity 3: "Cheers Me Up, Puts Me Down"

This last activity aimed to address another aspect that was planned to be included in the music application: the relation of music with emotions, and in particular how to best represent these feelings (i.e. by smiley faces or emoticons). The activity looked at what type of associations children were able to make between music and moods or emotions. The children were provided with a pre-printed sheet of paper with five different facial expressions (emoticons). They were then asked to write (or draw) next to each facial expression a related song. If the children could not think of any music (sound, song, instrument) they were encouraged to write what emotion they thought the emoticon represented.

Figure 3.10 An example of an emoticons sheet completed by a child

Apart from 'happy' and 'sad' faces, that are the most clearly recognisable, the other three smiley faces (gnashing teeth, frowning, and winking) suggested different interpretations, like 'angry', 'confused' or 'cheeky'. An example of the emoticons sheet can be seen in Figure 3.10. Since children were already introduced into the song and music context by the previous activities, it was easy for most of them to come up with songs for the different emotions. The emotions that were ambiguous (like 'worried' or 'puzzled') were the ones most children left incomplete. These types of emoticons were intentionally included to further investigate children's abilities to interpret facial expressions and make associations. An additional instance of this activity was added after the first design study. To explore the same type of association from the opposite perspective, children had to listen to two different types of songs (one after the other) while drawing on a blank paper how the music made them feel. The two songs differed in rhythm; one had a faster tempo, a popular children's rap song and the other was a slower, more ambient type of music. All the children seemed to be at ease with drawing what they were feeling in relation to the type of music they were listening to.

3.3.4 Analysis of the Outcome

When analysing the sessions' outcomes, the research teams focussed on the challenge of integrating the children's innovative ideas into concrete solutions. All the activities contributed to a rich body of information related to the context of the research project. While most of the activities provided contextual information for the project, some of the children's outputs proved to be also direct inputs to the design of the music device. Information about the content to include in the interface came from the two design activities (the ones relating music with a landscape "If I were there I would play this", and with moods "Cheers me up, puts me down") that were related to initial design concepts defined in the project. Outputs from this activity were then analysed and developed further by the design researchers and evaluated with children before being included in the final product. The process for developing children's contributions into a design input followed a process based on the Bluebells method (Kelly et al., 2006), where the outputs from the session with children were analysed, interpreted and adapted to the design context and then brought back to children for further evaluation (a more detailed description of the follow-up of this project is in Mazzone et al. (2012)).

3.3.4.1 Analysing Activity 1 "Magic Music Toy"

The children produced different kinds of musical instruments, radios and varied multi-instruments or music makers. All of the objects were clear, tangible and colourful. More than half of the resulting products from all the sessions resembled existing music instruments, some with added fantasy features. A few other prototypes were more like music players (e.g. iPods or radios, as in Figure 3.11b), while a minority were completely original ideas. Most of the objects had physical components that could either produce real sound (or rather 'noise') or make it portable and wearable (see Figure 3.11a). Younger children's output was more bi-dimensional (sticking cut-outs on paper sheets) compared to the older children (creating three-dimensional objects with cardboard and provided materials) but their ideas were generally more imaginative: many used teddy bears or fantasy objects as their music players.

a) 

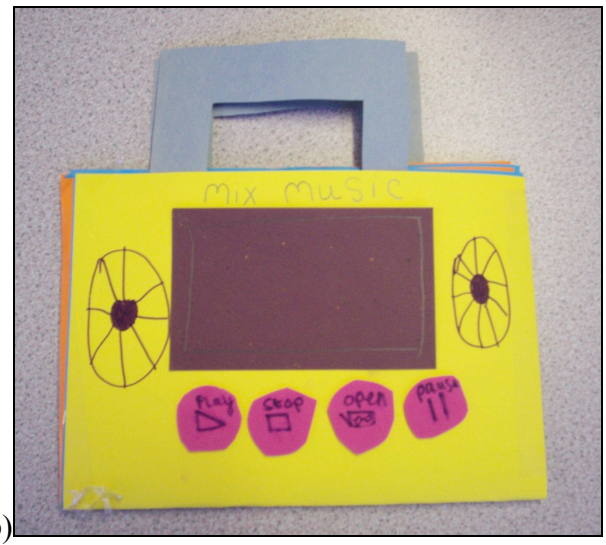
b) 

Figure 3.11 a) and b) Examples of two different prototypes made by children

The output from this activity gave an understanding of the generic attitude of children towards music and music players or instruments. The research team was able to figure out the instruments that the children were more familiar with and to get an understanding of the playful way the children interpret and perceive a device to play music with by both carefully observing details in the artefacts the children had produced and by examining the verbal descriptions the children had provided in relation to their outputs. In all the sessions, this activity also provided insights on collaborative aspects, as some children did work on the idea of sharing their music toy with others or the notion of synchronising it with their friend's prototype. Although this activity was intended to be mainly inspirational and evocative, it also gave information that could be directly applied in the product design. The building of their magic music toy highlighted children's preference for personalisation: children liked covering their objects with personal gadgets, names, and drawings. In addition, the tangible and three-dimensional aspects embedded in most of the prototypes were taken into account in the interface of the final product and some ideas of the buttons produced by the younger children were included in the product prototype, after further design iterations.

3.3.4.2 Analysing Activity 2 "If I Were There I Would Play This"

Outcomes from the second activity confirmed the design idea of including soundscapes to differentiate three sets of music, namely the association of fantasy music with a castle, urban music with a city environment and natural sounds

represented by a jungle. In this task the jungle was associated mainly with different kinds of percussion instruments and with natural sounds, like birds and the wind, the castle was associated with trumpets and other kinds of blown instruments, and the city was associated with mainly hard sounds like rock music instruments (drums, guitar). An example of children's drawings for this activity can be seen in Figure 3.12.

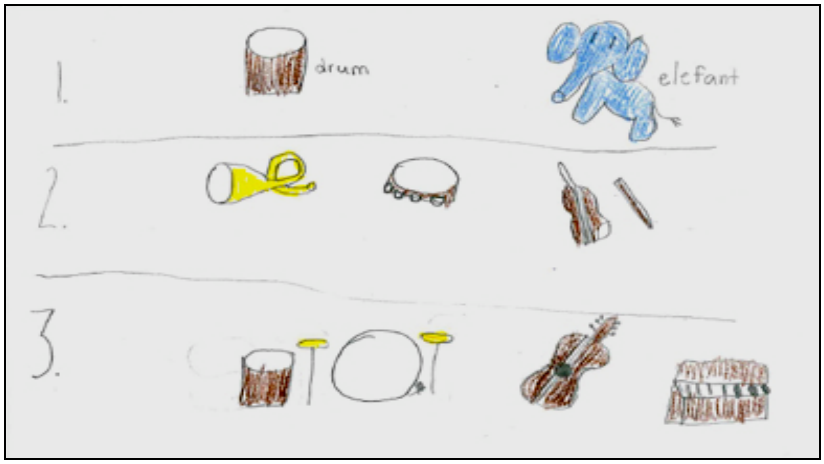


Figure 3.12 An example of children's association of instruments with the three landscapes (a jungle, a castle, and a city)

Overall, the drawings showed consistency in children's associations between music and places, especially in the version of the activity with the pre-printed landscapes, for example, including percussion instruments in naturalistic places and string instruments in more artificial ones.

3.3.4.3 Analysing Activity 3 "Cheers Me Up, Puts Me Down"

When associating music with moods, children demonstrated the ability to relate their feelings with different types of music and showed that they were comfortable expressing their feelings through drawings. The version of the activity with the pre-printed emoticons also provided contextual information on how easily children interpret basic emotions (happy/sad smiley faces) in relation to music. For the younger children this activity proved that they could not really understand the representations of the more subtle variations of emotions, and were really only able to understand the happy and sad emoticons (Mayer et al., 2000).

For the free drawing while listening to music, some children drew a series of different smiley faces as their feelings were changing during the song. Drawings for

the first song transmitted ideas of movements and joyfulness, while the second one inspired images of peaceful sensations and calm situations.

Figure 3.13 Children drawing while listening to music

Figure 3.13 shows an example of children's drawings while listening to the fast tempo music – the child on the top of the picture drew lines with different peaks as the music was changing rhythm, while the child on the front drew a smiley face and different objects in a landscape.

3.3.5 Reflections on the UMSIC Design Case

The participation of research teams distributed in different countries and the length of the project offered the opportunity (and the need) for a shared understanding of the application of the co-design practice and a deeper analysis of the outcomes of the design session. This detailed analysis was developed especially after the joint session in Finland, where I was responsible for defining and analysing the design session with the Finnish team. The discussion with researchers concerned both the results produced by the children and the methods applied in the session. This distinction resulted in being particularly important in co-design sessions with children: whereas the value of a design session is measured by the design outcome and the influence on the design process, when the participants are children it is critically important to look at the impact of the activity on the children (Guha et al., 2010). Therefore, in the

analysis of the sessions the focus was also on the appropriateness of the design methods for the user group together with the ability of the method to truly invite and engage the children as design partners. In this process, the aim was to identify relevant factors in design activities that would go beyond the specific case study. The discussion led to the definition of a model for the analysis of co-design practices by looking at both the suitability and the capability of the design methods applied in the session. According to this model, methods can be looked at depending on how suitable they are to engage children as active participants (suitability of a method) and how capable they are to produce useful results for the design (capability of a method).

One of the contributions I derived from the UMSIC design experience for this research is the definition of parameters for the analysis of methods in relation to the design sessions in which they are employed. With regards to the capability of a method, the children's output was classified either of a more abstract and inspirational value for the understanding of the design *context* – i.e. their ability to relate type of music with specific landscapes – or of a more concrete and practical value for the *content* of the product – for example if it contained ideas for functionalities or objects that had not been thought of. The design activities described for this project succeeded in providing both contextual understanding of children's abilities and preferences related to music, as well as useful content to be included into the prototype of the application. Table 3.2 summarises the parameters related to the capability of the methods.

Table 3.2 Parameters for the analysis of the capability of methods

Context information	Content information
Children's insights and perceptions of the product's context	Children's ideas and concepts for specific product's elements (content, navigation, interaction, visualisation)

Two aspects were identified to play a key role in determining the suitability of methods employed in the sessions: *management* and *engagement*. The first aspect relates to the careful planning of the sessions, with defining roles, timing, and data collection. In the management of the roles of the facilitators, the presence of different expertise in the team, like music educators, was critical, together with the presence of

the teacher. Teachers' interventions need to be defined beforehand (Pardo et al., 2005; Mazzone et al., 2008b); during these sessions, the teachers' intervention was two-fold: on the one hand, related to the educational aspect, when commenting on the adequacy of the activity for the specific group of children; on the other, ensuring a smooth flow of the session by sharing information on how to handle the class. Another aspect that emerged from the design activities was the importance of recording the children's output, not only by taking pictures of the physical outcomes but continuously observing the actual progress of the task. Children's drawings, writing or prototypes are often hard to interpret per se, making it difficult for an adult to understand what the children's pictures are meant to represent. Encouraging children to explain their ideas, both while they are producing them as well as once they are completed at the end of the activity, helps the researchers' understanding and interpretation of the outputs.

The second aspect, *engagement*, refers to ways of enabling children's active participation, by trying to also introduce a fun element: not only should the products designed for children be fun to use (Fontijn and Hoonhout, 2007; Barendregt and Bekker, 2004) but also the methods used for co-designing with children should be fun so participants can become, and stay, engaged with the activity. Of particular importance was the use of multiple channels for children to express their ideas in their preferred way, as well as the use of multiple kinds of props (trigger video or music) to encourage their imagination and interest as important. Table 3.3 presents the parameters related to the suitability of the methods.

Table 3.3 Parameters for the analysis of the suitability of methods

Session management	Participants' engagement
Importance of thorough planning; Clear definition of roles; Progressive collection of data;	Use of multiple channels for expressing themselves; Use of props to trigger creativity; Inclusion of fun elements

To summarise, all the lessons learnt about co-design practice in this project (U for UMSIC) were:

U1 – Facilitators' management of the session and children's engagement identified as the two factors that affect the experience of the sessions and their outcomes

U2 – Outcomes analysed according to their contribution to the context and the content of the design

U3 – Facilitator roles (researchers and teacher) were clearly defined at the beginning to limit biases on children's ideas

U4 – Recording children's explanations during their progress was useful for a clearer understanding and interpretation of the session's output

U5 – Using prompts with different formats (i.e. video, music) helped the engagement of the children in the activities

U6 – Having variation of an activity (i.e. same goal but different ways to achieve it) increased the opportunities to achieve the design aim.

3.4 Summary and Conclusions

The description and analysis of the three projects presented in this chapter contributed to define relevant elements that determine design activities. This way of breaking down components of design projects corresponding to the sections of this chapter was useful to identify relevant variables that need to be taken into account in running co-design sessions. The table below (Table 3.4) summarises the features of the three projects and the lessons learnt from the co-design activities for each of them.

Table 3.4 Summary of the three projects and lessons learnt

	BEAM	COOL	UMSIC
Project objective	Use broadband technology to support school visits to museums	Train disaffected teenagers to deal with emotions through a computer game	Support music making and playing amongst children through a mobile device
Research team	Interaction designers; Web developers	Psychologists; Interaction designers; Web developers;	Music educators; Interaction designers; Usability experts; Developers
Participants	Museum curators; Teachers; Schoolchildren	Carers; PRU's and mainstream schoolchildren	Schoolchildren from 5 to 10 years old in Finland and England; Teachers
Constraints	Defined technology (broadband); Rigid milestones; Restricted access to school and museum network	Defined content (emotional intelligence modules); Dependence on schools schedule and calendar; Unpredictability of users' behaviour	Design team spread over three countries; Defined mobile device (Nokia N900)
Design objectives	Understand: - children's knowledge of museum terminology; - children's experience of museum visit; Explore children's interaction and navigation of educational website	Understand: - children's everyday vocabulary; - children's interests and familiar contexts; - children's literacy and computer skills; - children's understanding of emotions	Explore children's ideas of music players; Test initial design concepts; Generate abstract design concepts
Design activities	Thought shower on museum visit memories; Creating web content and interactions with provided tokens;	Game scenarios and award system; Storyboards and plasticine stop-motion animations; Labelling facial expressions; Drawing emoticons	Drawing and prototyping of the 'magic music toy'; Drawing of landscape associated with music; Associating music with emotions
Design outcomes	Relevant content of museum visits for children; Children's ideas of web elements and interactions	Children's values for praise; Children's interests; Children's familiar contexts and wording; Children's interpretation of emotions	Variety of combined instruments and fantasy objects; Consistent association of landscapes and type of music; Consistency of emotions associated with music.
Lessons learnt	B1: Inclusive design implies more attention on collecting data and management of resources; B2: Data analysis needs to take into account data generation: i.e. group dynamics, copying behaviours, prompts' bias; B3: Group dynamics as idea trigger; B4: Structure of a design session as before, during, after moments to identify all the resources and requirements;	C1: Consider multiple intelligences when planning activities; C2: Open mind to embrace unforeseen results; C3: Benefits for children: educational (learn and develop skills), personal (increase self-esteem); C4: Importance of coordinating facilitators; C5: Context can be more relevant than age for determining the suitability of the activities; C6: Importance to plan for	U1: Management and engagement as two factors that influence the success of the session; U2: Analyse output according to context and content; U3: Clear definition of facilitators' role; U4: Progressive record of children's explanations; U5: Use of prompts of different formats to engage children in the activities; U6: Importance of

	B5: Closing up sessions with outcome presentation	unexpected situations.	variations of a design activity.

The knowledge acquired in the analysis of these three projects is used towards expanding on the answer to RQ1 on breaking down the complexity of the co-design practice. At the same time, the learning derived from these projects provides an initial approach to RQ2, on identifying key elements that influence co-design sessions, further developed with the creation of a model of the co-design practice, as described in Chapters 4 and 5.

4 CHAPTER FOUR: DETAILING THE CO-DESIGN PRACTICE

Following the analysis of the data collected through the exploration of the research context (Chapters 2 and 3), this chapter has a more reflective perspective towards understanding of design sessions as instances of design practice. This chapter presents a description of design sessions as instances of co-design practice as derived from the knowledge collected from literature on co-design practice with children discussed in Chapter 2 and from direct experience reported in Chapter 3. In this way, the elements involved in co-design sessions are made explicit in the process of providing support for novice designers in the reflective practice. In the following sections, after briefly introducing reflective practice in design (Section 4.1) I first summarise the factors that emerged as relevant in co-design practice with children (Section 4.2) and then present them in a way that aims to be useful to novice practitioners when undertaking co-design session (Section 4.3). Describing the different stages of a session helped to understand the variety of elements that are deployed throughout the process and therefore completing the answer to RQ1 (breaking down the complexity of the co-design practice) and RQ2 (defining relevant factors for co-design sessions). The structure of a co-design session introduced in Section 4.3 is the first step towards modelling a co-design session and therefore addressing RQ3.

4.1 Reflective Practice in Design

As anticipated in Chapter 1 (Section 1.3), research in Interaction Design needs a deep understanding of the practice in order to support it (Stolterman, 2008). Reflections and critical studies on the discipline have argued that although there are many theories, models and guidelines available, design practitioners normally refer to concrete techniques and approaches they are familiar with (Rogers, 2004). As stated by Fallman (2003) there is no such thing as a defined way by which theories, fieldwork, and evaluation analysis turn into design. Design does not happen as a unique correlation between requirements and final product: it is considered as the result of a complex process of unfolding a whole through all the different elements gathered through research, not by just adding them up (Fallman, 2003). According to Schön (1983), every design task is a unique ‘universe’ that experienced designers are able to approach but without being able to describe it in a transferrable way.

Therefore he proposed the practice of reflection-in-action based on a constructivist approach, as a way to make explicit this implicit knowledge through the alternation of reflection and action with designers being encouraged to actively build a representation of their experience that can then be taught (Valkenburg and Dorst, 1998). Reymen and Hammer (2000) defined a method for supporting practitioners in regular reflection on design situations. In doing so they divided the design process into design sessions, where reflection can happen when describing the design state before and after each design session. They provided a detailed categorisation of design sessions, activities and tasks in order for designers to be able to identify factors and properties of the design process and context and become aware of the design situation they are immersed in. According to their research, the need for this awareness of the design situations at specific moments helps in the decision taking process and influences the following action to take. This reflection also improves the current design process and at the same time provides important knowledge for improving design skills for future design processes (Reymen and Hammer, 2000).

As opposed to scientific disciplines, in Interaction Design, practitioners, especially novices, rather than being 'guided' through the methodological process need to be 'prepared' for it (Schön, 1983; Stolterman, 2008; Hornecker, 2010). Therefore, this research is going towards creating support for reflection rather than in delivering prescriptive guidelines.

4.2 Elements of a Co-Design Session

This section details all the elements that emerged from the knowledge gained from the literature review and from experience in design projects. These elements are presented according to the design session's stages (Section 4.2.1) and the perspectives of management and engagement (Section 4.2.2). Where applicable, the different elements refer to the specific instance of lessons learnt identified and labelled in chapters 2 and 3 in order to make the relation explicit (following the same coding as LR from literature review, B from the BEAM project, C from the COOL project and U from the UMSIC project – a complete list of the lessons learnt is in Appendix 1).

4.2.1 Stages of the Co-design Session

Thinking of the co-design sessions as having a before, a during and an after moment (Kelly et al., 2006) helps to see all the elements implied in each stage and to recognise that all the three phases are related to each other: what happens in each moment influences and has an impact on the following one (B4). Therefore it is important to think thoroughly of the decisions to take on each aspect, in order to be prepared for what to do in and what to expect from the design session.

4.2.1.1 Before the Session

This part concerns the understanding of the design problem, or design situation, in order to identify the design objectives and define the design focus of the sessions. Preparing for the session also involves the understanding of the different resources available and a thoughtful planning of the session by optimising these resources for the achievements of the objectives. Running a pilot activity with a small sample of children is a good practice that is often overlooked but can help avoid major pitfalls during the actual session and compromising the achievement of the goals (Rode et al., 2003; Hanna et al., 1997). At the same time, having every single detail planned and controlled should not imply having a too rigid plan: a little level of uncertainty and freedom is always advisable to adapt to unexpected situations.

4.2.1.2 During the Session

After a thorough planning, the actual co-design session with children can be experienced by focussing on children's engagement rather than looking after pitfalls. Having a clear plan and objectives for the session should not prevent having an open and flexible mind and being prepared to notice and gather valuable information even if it differs from the one initially sought for (C2). At the beginning the facilitators need to introduce the children into the activity, by presenting the topic and detailing the actions required from them. Then, the immersion in the activity follows, when the children are actually engaged in the tasks. The session normally ends with a wrapping-up stage, when the researchers collect the results and make sure the information is properly recorded, while allowing the children to get a sense of achievement and completion.

4.2.1.2.1 Starting the Activity: Brief

When the children are gathered in the space arranged for the activity, the researchers introduce the members of the design team, the purpose of the activity, and explain in simple terms the reason why the children's contribution is being asked for. Using examples or prompts helps the children to get started (U5). When working in a non-familiar environment for the children, as a research lab can be, a quick mention on logistics should be included, e.g. toilet location and fire alarm conduct.

4.2.1.2.2 During the Activity: Design Task

While the children are performing the required tasks, the participation of the researchers is usually limited to supplying supervisory support and providing additional clarification when needed (U4). The intervention of the researchers can be necessary when possible loss of focus from the main activity purpose occurs and there is a need to bring the children back on task. In most instances, researchers are mainly engaged in observing the activity, and taking records of relevant elements at any stage by taking notes, pictures or video (U5).

4.2.1.2.3 Ending the Activity: Debrief

Before the end of the session, an appropriate amount of time (depending on the number of children) need to be scheduled for wrapping up the work and preparing for plenary presentation of the outputs, each followed by praising the contribution. This activity is useful for researchers to have a general idea of the outcomes of the session and for children to get a sense of accomplishment (B5). Before the final thanks and farewell, good practice is to provide an insight of the way the children's contribution is going to be used and the children should be told whether they can keep the outcomes of their work or if they will be given to them later.

4.2.1.3 After the Session

The analysis and interpretation of the session's results can be considered the most challenging part. For this reason, it is crucial that thorough thought is given before the session on what information is being sought and for what purpose (B4). In the same way, it needs to be made sure that during the session this relevant information is properly collected and recorded (U5). There are different plausible ways to go through the results, from mainly inspirational to thorough analysis and interpretation (U2). In any case the researcher should also be aware of the way the outputs are

produced (B2, (Mazzone et al., 2008a)) as this may affect the type of results and mislead the interpretation of the data. From the same group of data it is therefore possible to conduct various analyses adopting different perspectives and also end up with finding useful results not previously planned. Children can be iteratively involved in the analysis and evaluation phases (Kelly et al., 2006), to bring abstract ideas closer to design inputs (Mazzone et al., 2012). The table below (

Table 4.1) summarises the main elements included in the three stages.

Table 4.1 Overview of the stages of design sessions

Stages		
Before	*During*	*After*
Objectives	Brief	Analysis
Resources	Design activities	Evaluation
Pilot	Debrief	

These considerations are a foundation for all the different instances of co-design practice, regardless they are in lab or field sessions, with small or large group of children, for long or short project duration.

4.2.2 Management and Engagement perspectives

The description of these three stages of the co-design sessions served to put the elements into context; in this section I describe in more detail all the elements that play a significant role. They are organised on the basis of the criteria that emerged from the discussion for the UMSIC project (Chapter 3), distinguishing between aspects of the design sessions that need to be considered for the management of the session and for the engagement of the participants. This classification proved to be useful to cover the main aspects involved in the co-design practice while emphasising the importance of the children's and the researchers' roles (U1).

4.2.2.1 Management

All the issues concerned with the management of a co-design session with children are hereafter grouped according to whether they refer to the design process, the role of the facilitators, the logistics, or the collection and analysis of data.

4.2.2.1.1 Design process

Design focus. As described in Chapter 2 (Section 2.1.1, LR1) after taking into account the different design models and practices, the design process can be summarised as the iteration of analytical, generative and evaluative phases that are strongly interconnected. Each of these phases has a different design focus, according to the maturity of the project: the 'analysis' includes researching, understanding, studying and inquiring into the context and the users, eliciting and defining requirements as well as analysing information and results, depending on which cycle of iteration the design is at; the 'design' focuses on generating divergent or convergent concepts, taking design decisions, sketching, prototyping and implementing design solutions; and the 'evaluation', that can be either exploring the existing products and activities or testing and validating concepts, prototypes and situations. Each design session focuses on one or a combination of these activities (Marti and Rizzo, 2003).

Designer role. As underlined by many researchers and practitioners (Agostini et al., 2000; Scaife and Rogers, 1998; Williamson, 2003), in this thesis, the co-design practice with children is defined as not to equally share responsibilities between designers and user participants (LR4). Rather than diminishing the importance of children's roles and skills the aim is to allocate responsibilities and roles according to the participants' nature. While children's invaluable input is recognised as informants, a thorough process of analysis and implementation is the work of researchers (LR2). With this perspective the design lifecycle is considered as an alternation of child participation and designers' only analysis, where after each co-design session the designers process the results before involving children again in a progressive manner (Kelly et al., 2006, Mazzone et al., 2012).

4.2.2.1.2 Role of the facilitators

Coordinate facilitators. Multidisciplinary teams can cover the different perspectives related to the specific context of use of a product. In a co-design team different expertise are needed, especially the ones related to pedagogical experience and specific topics of the design context (LR6). This multidisciplinarity implies also the possibility that some of the facilitators are not experts in co-design or do not share the same views on how to conduct co-design studies with children (C4). This situation requires that a common understanding of the roles and behaviours of the

facilitators is agreed amongst the participating researchers: this is to avoid providing different instructions or level of support to the children that may lead to confusion for the children or bias in their contribution (Luck, 2007). When a whole class is involved in an activity at the same time, facilitators can be allocated to one specific group of children or circulate amongst different groups, depending on the number of facilitators available and the children's and tasks' characteristics (B1).

Involving teachers or experts. In many cases, children who are involved in co-design sessions are accompanied by adults. There are many degrees to which teachers, carers, or parents can be engaged in the session: what is agreed to be important is that their presence should not influence children due to the established power relation implied in their position (Alborzi et al., 2000; Williamson, 2003; Pardo et al., 2008). Teachers or adults that know the childr participants well can provide useful information on the suitability of the activities planned for the co-design session beforehand or useful tips or strategies to manage children's behaviour and attention, habits or routine, or social dynamics within the groups of children (U4). All this information contributes to reducing the occurrence of unexpected situations and thus allowing the session to run without a hitch.

4.2.2.1.3 Practical aspects

Ethics. As in all research involving people, ethical issues are a first priority also for work with children. Apart from practical issues and logistics for preventing any conditions that may provoke physical harm, special attention needs to be paid to developmental aspects. Children's sense of privacy and security is not as developed as in adults: being in a continuous process of building knowledge by absorbing information from others, children tend to be overly trusting and vulnerable (Dawkins, 1993; Moses and Baldwin, 2005). This developmental condition makes them prone to disclose private and sensitive information without pondering possible consequences (Vanderbilt et al., 2011; Nolan et al., 2011). It is the researcher's responsibility to avoid such situations and ensure the confidentiality of data (Christensen and James, 2008). In the same way, researchers are to supervise and look out for the adequacy of the content and the information children access during the session, both online or in person (Read and Mazzone, 2008).

Understanding of before, during and after stages. The co-design session is not limited to the design event with the children: it is strongly connected to the planning and the analysis of it (B4). Although this connection sounds obvious it is often underestimated. It is not enough to plan fun and entertaining activities related to the design subject – if the goal is to have design sessions that contribute to the design of a product, then the information sought has to be defined beforehand and ensured during the activity in a way that would be suitable for later analysis.

Importance of detailed arrangements. When children are involved in design activities, some degree of chaos is to be expected. Apart from spontaneous and unconventional behaviour of children that is related to the unpredictability of their nature and their sensitivity to external situations (Rode et al., 2003; Barendregt, 2006), other unplanned events can occur during the session. These events can relate to the location of the session, especially if it is a non-controlled lab, i.e. a school, where interruptions, like school assemblies or extra-classroom activities, are not easy to predict and interfere with the planned activity (Rode et al., 2003; Read and Mazzone, 2008). These unexpected situations can also relate to last minute changes that were not communicated on time, such as changes of allocated spaces or fluctuations in the number of children. Not all of these events can be anticipated, but researchers can be prepared for it, for example by having alternative activities to adapt to changing conditions, i.e. time duration or logistics (C6).

4.2.2.1.4 Collection of the data

Ways to collect data. The way to collect the data resulting from a co-design session will inform the subsequent analysis. The selection of the different methods will depend on resources and constraints (ETR Associates, 2007). Video recording the session will guarantee to capture details that can be missed during the session and also allows the possibility of an objective analysis by a third party afterwards, but it is not always possible to use a video camera, either for privacy issues or lack of resources or staff. Note taking is a widely used method of capturing events together with the researcher's reflection in the moment. Interviews or questionnaires at the end of the session are also used to collect children's opinions, preferences or comments (Read and MacFarlane, 2006).

Recording the ideas' progress. As discussed in the UMSIC project (Chapter 3, Section 3.3.5), children's artefacts can be hard to interpret by an adult without the related children's description. Observations, notes, video or audio record help capturing details and information that will be useful while analysing the data after the session. Also, their ideas usually vary during the process and it is therefore interesting to grasp its evolution and modification in the moment it occurs (U5). This additional information can be achieved by interviewing the children during the progress of the activity as well as at the end of the activity. Individual interviews, collective presentations or focus groups are different ways to collect this information according to the design situation and suitability for children.

4.2.2.1.5 Analysis of the data

Data generation. One aspect that affects data analysis is data generation. As seen in the Beam project (Chapter 3, Section 3.1.5) and in Vaajakallio et al. (2009), group dynamics influence the way children produce ideas. Whatever the decision of how to group children was, analysing the results within groups and between groups gives extra information on how the idea may have come out and how it needs to be considered (B2). In the same way other biases (e.g. possible constraints of the tools used in the activities or some facilitators' intervention and comments) may influence the outputs and its analysis, especially if it concerns variety, originality or number of ideas.

Methods to analyse outputs. There are ways to measure and describe design outputs from adults that concern for example originality and novelty (Shah et al., 2003), or analyse designer conversations (MacLean et al., 1996). Outputs from co-design sessions are not 'ready to implement' design ideas. The way to analyse artefacts or information gathered during the design session varies depending on projects and researchers, without there being many formal methods (Kujala, 2008). When these outputs are generated by children, the analysis needs to take into account also factors related to their developmental stages and abilities. There are attempts to adapt adults' measures to children's outputs. Sluis-Thiescheffer et al. (2007) for example, applied a variation of the Question-Option-Criteria method (MacLean et al., 1996) as a way to compare design outputs of different formats starting from children's descriptions. What matters about the method chosen for the analysis of children's outputs, is its consistency with the design session objective and focus, whether it was inspiration

for design or specific design details. As discussed in Chapter 3 (Section 3.3.5) for the UMSIC project (Mazzone et al., 2010), an initial classification was adopted between information that contributed to a more general view of the design context compared to information that was more specific to the content to be produced (U2).

4.2.2.2 Engagement

In a similar way as it has been done for the *management* aspect, this section presents the issues regarding the engagement of the participants. Its elements are clustered in relation to: the techniques applied for the activities; the perspective of children involved in the activities; and the variation of formats.

4.2.2.2.1 Techniques

Techniques available. Table 2.1 in Chapter 2 lists techniques to apply in co-design activities together with related information relevant for their selection for co-design sessions regarding: their main aims and context of application, examples and variations of their application, pros and cons of their application, and details the required skills from children. Although such a table cannot possibly include all the existing techniques to employ in co-design sessions, it mainly serves as a collection of commonly used types of techniques and references to examples of their applications. The implementation of each technique has then to be adapted to fit the topic and objective of the specific instance.

Adequate methods. As stressed by (Sluis-Thiescheffer et al., 2011), in co-design sessions with children it is important to employ methods and techniques that are suitable to the participants' skills and abilities. This consideration is beneficial both for the success of the session to enable children to produce outcomes that are likely to be useful and for the children to stay 'in the flow' (Csíkszentmihályi, 1990) by feeling challenged and at the same time at ease in completing the tasks (C1).

4.2.2.2.2 Children's perspective

Impact for children. Apart from addressing the adequate level for children's skills when selecting the techniques, it is also important to set the right topic and focus of the activity with the children's interest and knowledge, in order to stimulate their engagement and fruitful participation (C5, U6). It could be the case that the topic of the project is new and unfamiliar to the children but the way it is presented can make references to relations with concrete aspects that are easily understandable for them.

Even if it is not the main aim of co-design session, it is favourable to also think of the benefit and the impact that the co-design activity will have on children, whether it could be educational, it could let children learn and develop new skills or it could improve children's self-esteem for their significant contribution to a design project (C3).

Group dynamics. The way children are engaged in the activity may depend on many factors. According to their cognitive and social development, they can be more or less at ease in working alone rather than in groups. On the one hand, group work can stimulate discussion and idea building but may end up in cognitive tuning (B3); on the other hand, working individually with children allows the design team to go into depth on topics and explanation but may inhibit children by emphasising the power imbalance (Sluis-Thiescheffer et al., 2011). Logistics and practical constraints may also affect the decision: where less time is available, working in groups is the only way to involve a large number of children in short time (B1). The availability of researchers and facilitators can also dictate the number of work groups and the way information is collected and details are grasped.

4.2.2.2.3 Multiple formats

Consider multiple intelligence effect when planning activities. In a similar way as to select methods that are suitable for children's skills and ability, introducing multiple modes for the children to express their ideas in an activity will guarantee most of them will have the opportunity to find a communication channel that is suitable to their preferred intelligence or ability (Druin, 1999; Sluis-Thiescheffer et al., 2007), (C1).

Use of props. The engagement of children can be facilitated by the use of props or triggers. As the video presented in Briggs and Olivier (2008) and Read et al. (2010), or the music samples employed in the UMSIC project activities (Chapter 3, Section 3.3.3.1) did, supporting the briefing of the activity by using multimedia props provides the children with concrete examples to refer to and helps them getting started with the activity (U6).

Variations of an activity. The same design activity can include variations of techniques while still keeping the same objective and intended goal (LR5). As seen in the UMSIC project activities (Chapter 3), variations of the same activity were

included to countercheck the results and also give the opportunity for children to convey their ideas through different ways, depending on their skills and capabilities (U7).

Table 4.2 and Table 4.3 below give an overview of the different elements to consider in design sessions from the two perspectives of management and engagement discussed above.

Table 4.2 Components of the *management* aspect of a co-design session

Design Process	Facilitators	Practicalities	Collection of data	Analysis of data
Design focus; Designer role	Coordination; Expertise	Ethics; Session's stages; Arrangements	Methods; Frequency	Generation; Interpretation

Table 4.3 Components of the *engagement* aspect of a co-design session

Techniques	Children's perspective	Formats
Selection; Adaptation	Impact on children; Group dynamics	Multiple intelligences; Props; Variations

4.3 Planning a Co-design Session

After having defined elements that are relevant to co-design sessions, this section presents a way to structure these components in order to ease researchers' practice and therefore contribute to answeing RQ3 on how co-design sessions can be formalised to support practitioners. I compiled a Design Planning Document (DPD), according to the elements and perspectives introduced in the previous section, to assist novice practitioners in planning and coordinating design studies that involve children. Following the reflective design approach and the need for designers to reflect on their practice presented in Section 4.1, the DPD aims to provide practitioners with references for reflection when planning a co-design session rather than a set of guidelines to comply with. To do so, the support of the DPD in defining the design focus and the criteria to follow when defining the activities includes:

- brief descriptions of the different stages of the process and of the different factors and variables to consider when making specific design choices would help clarifying objectives and expectations;
- list of design techniques and their references to adapt to each specific design context;
- action boxes along the different stages to encourage reflection during decision-making and assist the creation of the session plan.

As further discussed in Chapter 5, this document was conceived as a prop to facilitate discussion around co-design sessions in field studies with designers who were engaging in co-design activities with children for the first time. The document is attached in Appendix 2 and its parts are detailed hereafter. The way the DPD was used is reported in Chapter 5.

4.3.1 The Design Planning Document

The DPD is derived from the knowledge collected both from the literature and from direct experience on co-design with children and presented in Section 4.2 of this chapter. This information served to understand the requirements of running design sessions, define a suitable structure, and identify relevant variables. The resulting document intended to encourage reflections on the aspects that are significant in determining the success of a co-design session and to support the decisions on the relevant variables for the planning of the session. As it was mainly intended for researchers who have little experience in planning and leading co-design sessions with children, the DPD aimed to provide a structured route starting with general understanding of the design scope and definition of objectives and variables before heading to details of the design session. To cover all the important aspects of the plan that would influence the session's output 5 wh/hw questions (*what, who, when, where, how*) were used. The use of these dimensions is often used to identify relevant aspects of a topic: Markopoulos et al. (2008) for example used a categorisation based on these dimensions in a similar way but focussing on defining aspects of an evaluation sessions. The diagram in Figure 4.1 visualises the structure behind the DPD.

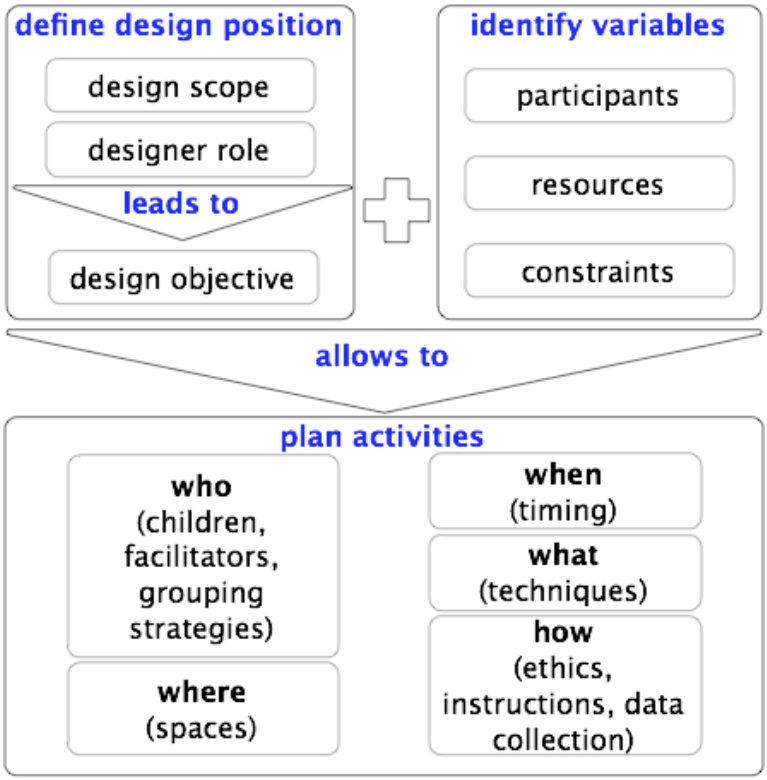


Figure 4.1 Overview of the DPD structure.

Each section has a brief description of its purpose and of the activities involved. Throughout the whole document there are several 'Action Boxes' within each section. These boxes include questions to trigger reflection and assist the decision-making process during the session plan.

4.3.1.1 Design Position

After a brief introduction on what to and what not to expect from the DPD, the first section set the groundwork to position the design scope in which the co-design session belongs. The 'egg' model from Marti and Rizzo (2003) presented in Chapter 2 (Section 2.1.1) was used as the basis for differentiating the three possible levels of design: whether it concerns the envisioning of new design possibilities (called 'envisioning'); the support of a well-known activity to solve an existing problem ('supporting'); or the improvement of an existing product ('improving'). This categorisation aimed to cover most of the design possibilities: the vast majority of design projects, although they can have aspects that fall in more than one level, have strong emphasis in only one of the levels. This differentiation served as the setting for the general design scope and guided the selection of objectives and techniques for

the specific design session. The 'egg' model was adapted to co-design with children by introducing a focus on children at each stage, as the contribution of children is essential whether it is for exploring the context of use, generating concepts, or evaluating ideas. Following the Bluebells approach (Kelly et al., 2006), the design process was presented as an alternation of children and designers working in collaboration where children act more like informants (Scaife et al., 1997) rather than equal design partners (Druin et al., 1998).

4.3.1.2 Define Session's Objectives

Within these three levels, the different design objectives that can be targeted were then highlighted. According to the different stage a design project is at, the design session can aim to get information on the context of the activity to design for, or to generate specific ideas for the suggested solution, or to evaluate and refine previous concepts. Each session that directly involves children needs a thorough analysis from the researchers to interpret and translate children's contributions into feasible inputs for the design (Sluis-Thiescheffer et al., 2007; Mazzone et al., 2012). Defining the objectives of the design activities beforehand will help in envisaging realistic expectations on the possible outputs of the co-design session and preventing later disappointment.

4.3.1.3 Identify the Variables

Together with defining the design session objectives according to the general project goal and its specific stage, it is important to identify the different factors that would play a role in the design session and influence its success. These factors are often already predetermined either by the characteristics of the project or by external circumstances. These factors can be grouped in three main categories: resources available (time, tools, spaces, technology), the participants who will be involved (children, researchers, stakeholders) and any commitments/constraints (whether there are fixed contents to fit in, specific technology to employ, or pre-determined targets to meet). Depending on each specific design project and situation, these variables can be more or less pre-determined and they will more or less influence the degree of freedom of choices that can be made when planning the session.

4.3.1.4 Plan Activities

Once the objectives and the variables are identified, the activities plan needs to make sure the co-design session meets the objectives according to the variables. The different aspects to consider in the plan were organised in, *Who*, *When*, *Where*, *What* and *How* dimensions.

4.3.1.4.1 Who

The *Who* included children and facilitators. When considering the suitability of children as participants in specific design activities the focus is on their different skills or intelligences (Chiasson and Gutwin, 2005; Sluis-Thiescheffer et al., 2011), which may depend not only on the developmental age, but also on social practice or culture (Iversen and Brodersen, 2008). According to the specific design situation, the activities to do during the session can be adapted to the participants' skills or the participants can be recruited to suit the design activities. Related to the participants is also the grouping strategy: either children will engage in the activities individually, in small groups, or as a whole class. Sometimes this decision needs to adapt to external factors: running a session at school may necessitate the taking of a whole class for one hour, or may, on the contrary, have the facilitator or designer working with one child or a small group of children who might be brought out of the class for a pre-defined period of time. Facilitators in a co-design activity play a delicate role; as they assist the children in the activities it is important that they share the same understanding of their role, of the activity goal, and of the expected output. While it might be desirable that they have expertise in varied domains related to the design topic, according to the different aspects related to the object of the design, facilitators as a group should have the same approach to assisting the children during the activities.

4.3.1.4.2 Where

The *Where* mainly refers to location, which distils into either field studies or controlled experiments. In co-design sessions this distinction normally means going into schools or bringing the children in a university lab and there are peculiarities for each settings that need to be accounted for by researchers. If it is an environment not familiar to children, e.g. a dedicated lab, depending on its set-up, the children can be distracted by new and interesting things they see around them but they can also feel more focussed as in a monitored setting. If the design session is held in a familiar

context for the children, e.g. at their school, they can feel more at ease and in control, but they can also be interrupted by contextual events not controllable by the researchers. Another variable that influences the activity is the space distribution, whether all the children are in the same room, doing simultaneously all the same activity or different activities, or whether there is a dedicated space for each activity.

4.3.1.4.3 When

Timing is another important factor. Some sessions involve more than one activity and there is a need to coordinate the shift in order to allow enough time for the children to complete, or swap over, tasks. Depending on the age and focus of the children, they may also need a break to keep their attention level at a suitable standard. Too much time is as problematic as too little, as if children finish ahead of time they may get bored if they do not have anything to do. It is a good habit to always plan some time for debriefing, done through each child or work group presenting their outcome either to only the researcher or to all the participants. This presentation of the results is both for the researchers to record the information and for the children to have a sense of accomplishment.

4.3.1.4.4 What

All the above variables will affect in one way or another the selection of the different techniques to apply in the activities. For example specific children are familiar with certain topics and have preferred channels for communicating and expressing their ideas. This section of the DPD included a table with a list of the most common techniques used in co-design sessions for children (Table 2.1 presented in Chapter 2). Each technique had a brief description of its intended aim and its relation to the different design activities of exploration, generation and evaluation. In addition, for each technique, the table provided some examples of possible applications and variations, detail of the required children's skills, and a summary of the pro and cons of their use. This list includes most type of techniques and includes references of their different applications, for practitioners to further investigate on and adapt to their design instances.

4.3.1.4.5 How

This last section started with a reminder of the need for strong ethics, with particular emphasis on assuring children's safety and privacy during the co-design activities.

For as obvious as it may sound, it is important not to underestimate this aspect, whether it concerns the institution's regulations or the children's freedom to drop out of the activity at any time. The section also includes considerations of the different ways to brief the activity and to collect data. The collection of data directly relates to the analysis of outputs, which is essential to determine the session's success. For example, the interpretation of children's output afterwards can be difficult and imprecise and so indicates a need for the proper collection of data and children's explanations in the moment.

4.4 Summary and Conclusions

In this chapter I adopted a reflective approach to analyse the practice of co-design with children and to reflect on how different elements are involved and intertwined during the session. Outlining the design session in three stages, before (preparation), during (design activities), and after (analysis) and adopting the two perspectives of management (of the session) and engagement (of the participants) served to identify the elements that affect the outcome of a co-design session with children. This represents a way to break down the complexity of the co-design practice and therefore answers RQ2. The information derived from this reflective process was compiled into the Design Planning Document (DPD) in order to provide a structure of co-design sessions as the initial step to addressing RQ3 on how to model co-design sessions with children.

The table below (Table 4.4) illustrates how the elements – emerged from the literature review and the design projects (chapters 2 and 3) and listed in Appendix 1 – are reflected into the DPD structure.

Table 4.4 Mapping the lessons learnt into the DPD structure

	Design position	*Design objectives*	*Session's Variables*	*Who*	*Where*	*When*	*What*	*How*
Literature Review	LR1, LR4	LR1, LR2		LR3, LR6			LR5	
BEAM			B1, B4	B3				B2, B5
COOL	C4	C2, C3,	C4	C4	C6	C6	C1, C5	
UMSIC				U1			U3, U4	U2, U5, U6

The DPD (Appendix 2) was devised as a prop for novice practitioners engaged in co-design with children to reflect on when planning a co-design session. Its application in field studies is described and discussed in Chapter 5.

5 CHAPTER FIVE: PARTICIPANTS' PERSPECTIVES

The analysis of the elements of the co-design session with children resulted in the definition of the Design Planning Document (DPD), described in Chapter 4, as a way to provide a structure to refer to for practitioners planning a co-design session. In this Chapter I describe the field studies where the DPD was used by practitioners as a prop for reflection. Investigating these researchers' perspectives about the sessions integrated the knowledge derived from literature and from direct experience towards a validation of the understanding of the co-design practice. The results from these field studies improved the definition of variables that play a significant role in managing the sessions and their outcomes, and at the same time provided requirements for a framework in support of novice researchers in the practice. The information presented in this chapter contributed to completing the answer to RQ2 around the key factors that influence co-design sessions with children and builds on RQ3 on how to model the sessions to ease researchers' practice. In the following sections, I first introduce the methodology used for the study (Section 5.1), by describing the participants involved, the material employed, the procedure followed and the method used for the analysis. The outcomes of the five studies are presented in Section 5.2 followed by the analysis of the information collected through the different sources (Section 5.3). In Section 5.4 I draw conclusions from the knowledge acquired from the studies towards the definition of a framework of co-design sessions described in Chapter 6.

5.1 Methodology

The methodology followed for these studies was an iterative process of testing and re-implementing the DPD provided as reference for co-design sessions. The procedure was repeated for each study as described in Section 5.1.3 using the same material as in Section 5.1.2, but a slightly improved version of the document was provided for the following study. The adjustments derived from the qualitative analysis of the information collected from the previous one, based on a Grounded Theory approach (Strauss and Corbin, 1990). The variations concerned clarity of terms or presentation of concepts highlighted by the researchers and were included in the DPD in order to avoid pitfalls or factors that would hinder the experience for the

researcher of the following study. The introduction of these alterations did not affect the results of the studies because the aim of this qualitative research was to build knowledge on varied experiences of novice researchers in co-design sessions and not to compare results from different researchers or design situations. For this same reason, although limited in number, the sampling followed a maximum variation strategy (Patton, 1990): each session concerned a different design project, focussing on different technology and targeting different age ranges of children, so as to cover a wide range of design situations, without limiting the case to a specific age group or a specific design stage. An overview of the conditions of the five studies is presented in Section 5.1.4.

5.1.1 Participants

For each study there was one lead researcher and a set of between three to five assistant researchers. All the researchers were part of the Department of Computing at the University of Central Lancashire, UK. All lead researchers had expertise in technology design but they had quite limited experience in planning and leading co-design sessions with children. In each session one classroom set of children (usually around 20 – 30 pupils) from local schools participated, each classroom being of a different school year, comprised in an age range between 6 and 12. All the studies were conducted in school environments in a single session, adopting a 'children as informants' (Scaife and Rogers, 1998) approach. As discussed in Chapter 2 (Section 2.2.2), the role of children as informants is the most commonly used in the research projects reported from the literature, as this level of involvement does not imply long term commitment and can reach a wide group of children at a time, especially in school (Williamson, 2003).

5.1.2 Materials

Together with the DPD with references for the co-design session plan (Appendix 2), the lead researchers were provided with different forms to fill in to inform the reflection on the co-design experience.

A pre-session questionnaire was submitted to each lead researcher in order to gain background information on their design expertise, to identify the design goal of the study and to uncover their expectations (Appendix 3). Lead researchers also received a brief description of the research that was being conducted and the process they

were expected to follow indicating the different forms and questionnaires to fill in (Appendix 4). They were provided with a research diary (Appendix 5) to take notes on the use they made of the provided tool and of any external aid they sought – from discussions with peers or expert designers for advice, to literature for reference of applications of specific design techniques. To collect children's feedback, lead researchers had to hand an evaluation sheet to children (Appendix 6), with a 'Smileyometer' from the Fun Toolkit (Read and MacFarlane, 2006) and two questions about the children's likes and dislikes of the experience. To triangulate the data collected and combine the different perspectives of the participants of the co-design sessions, both teachers and assistant researchers also had a form to fill in with their perceived positives and negatives of the session (Appendices 7 and 8).

5.1.3 Procedure

After having answered the pre-session questionnaire, the corresponding lead researchers went through the document describing the structure of the co-design sessions and planning the activities for their individual sessions. During or just after the study, the lead researchers took notes in a research diary. After the design activities, and before the end of the co-design session, each of these researchers handed questionnaires to children and to teachers. At least one of the expert designers who took part in the study as assistant researchers also provided written comments on the session. Each lead researcher was then interviewed about the overall experience of the co-design session. The interview was semi-structured, having open-ended questions about the design session (how they prepared for it, what happened during the sessions, what worked and did not work), and the DPD (how they used it, what they found more or less useful, what they would change), leaving also open space for overall comments. The five interviews were held remotely, all of them via Skype© teleconference, apart from one that due to technical problems had to be conducted on the phone. The interviews were recorded and notes were taken during the interviews. In an iterative process, after each interview some amendments to the reference document were made based on researchers' feedback before handing it to next researcher.

5.1.4 The Design Sessions

As anticipated in the 'Methodology Introduction' (Section 5.1) the design sessions differed in the level of design they referred to and the specific design objectives. This

differentiation followed the 'egg model' based on Marti and Rizzo (2003) and defined in the 'Design scope' of the DPD: the re-design of an existing technology (improving), the design a novel technology for a well-defined context (supporting), or the design of a novel technology for a novel context (envisioning). With regards to the session objectives, they varied from evaluating existing technologies and uses, to exploring children's activities and contexts, or generating new design concepts. An overview of the characteristics of the different studies is summarised in Table 5.1.

Table 5.1 Overview of the variables of the design sessions

Study	School Year	Project Type	Design Focus	Session Objectives
One	1	Tangible Technology	Envisioning	Concept Generation
Two	6	Web Game	Supporting	Concept Generation
Three	7	Mobile Education	Improving	Product Evaluation
Four	7	Web Game	Improving	Context Exploration
Five	3	Tabletop Game	Envisioning	Concept Evaluation

5.1.5 Method of Analysis

The results were analysed in order to identify common themes that could help to consolidate the understanding of the practice by answering the research questions:

- How do the participants (i.e. researchers, children, teachers) perceive their experience of a co-design session?
- What are the factors that influence these experiences?

The analysis of the information collected in each session's interview followed a Grounded Theory approach (Glaser and Strauss, 1999), where the coding categories were progressively elicited from the data of each interview and refined each time until considered exhaustive (Cairns and Cox, 2008). As advised by Strauss and Corbin (1990) a preliminary aim was set at the start of the analysis: finding common threads in the participants' perceptions of their experience of the co-design sessions. This research focus guided the analysis towards the understanding of what aspects influence the experience of the practice. Rather than biasing the emergence of categories as feared by Glaser (1992), having an initial focus reduced the risk of dispersion and helped not to lose the main objective of investigation (Mavetera and

Kroeze, 2009). The scope of the research question was, however, open enough to leave flexibility and freedom of exploration, whilst also able to be narrowed down as the research proceeded. As described in Section 5.3.1, the analysis of the transcriptions of the interviews with the lead researchers used a thematic analysis method, where the coding was driven by the specific research question (Braun and Clarke, 2006). The TAMS Analyzer© open software[6] was used to create and handle codes from text documents.

5.2 Results

In the following sections, for each study I present the context of the design, the project and the researchers' background together with their expectations on the sessions and then what happened during the session. This information came from the pre-session questionnaire, the research diary (Appendices 2 and 4) and the post-session interview.

5.2.1 Study One

The first study was led by a researcher with previous experience on the iterative design of interactive displays and mobile devices. He had limited experience in co-design with children, having participated in only a few design studies before as an observer or helper. In his first study as a design session coordinator, he was aiming to generate ideas to inform the design of a collaborative game for children using Wii-motes or similar input devices for interaction in a projected dome (planetarium). This study fell in the design level of 'envisioning', given that it referred to a novel application in a novel context that has not been previously explored. From involving children he was expecting them to indicate some preference for types of games in this context, and hoped to have them to design their own games for the dome.

The lead researcher went through the DPD and started planning the design session. He only found out at the last minute the details of the co-designers group, 25 children aged 5-6, and the time available, which made him refine his plan to engage young children for the session duration. His priority when planning the activities was getting the right pitch for the children, rather than only getting useful results for the product to design. In previous design sessions he had attended he noticed that

[6] http://tamsys.sourceforge.net/

researchers did not normally collect much data, so he wanted to focus on getting results he could actually use in the product design. Thus, he decided that for each group of children a facilitator would list all the ideas coming up in the brainstorming and then children would vote on these ideas.

5.2.2 Study Two

The second study involved a lead researcher who did not have much direct experience in designing technology but rather a theoretical knowledge of design, since he taught interface design as part of an undergraduate taught module. He had little experience in designing with children, having assisted at only one design session as a helper. For the session with children discussed in this study, the design concerned getting specifications for a few add-on games that would fit into a large game project. This design was more oriented to the 'supporting' level, as it intended to create novel products for a well-defined context. What he expected from the children was to provide ideas for the games in terms of game play, instructions, win/lose conditions, and to also get some ideas for the interfaces. He was hoping to collect outputs that, with little input from himself, could be turned into design specifications and implemented by game developers.

The researcher had a 1-hour session with 26 children aged 10-11. He already had in mind three scenarios he wanted the games to focus on. He checked his plan with experienced colleagues who were helping him during the sessions and as a result of this discussion he slightly modified his activities and their order. He divided the children into three groups, each working on one of the game scenarios.

5.2.3 Study Three

The third researcher leading a co-design session had expertise in creative design and usability. She had assisted in a few design sessions with children and she was going to coordinate one for the first time, with the object of the session being to redesign a music game for a mobile device. This session was therefore positioned towards the level of 'improving' an existing product for a defined context. Her expectations from the session were to be able to derive at least a few usable ideas, from general themes and from implications of children's designs.

The session took place for 1 hour in a class of 18 children aged 11 and 12, with one leading researcher and four other facilitators. After a brief introduction by the leader,

the class split into 3 groups each being assisted by at least one facilitator whose main role was to make sure that all the children wrote down their ideas. The number of working groups depended on the number of available mobile devices to redesign for. Each group spent the first 10 minutes getting familiarised with the device and playing with the already implemented game, before moving on to brainstorming and then spending the rest of the time producing designs by sketching on paper. Figure 5.1 shows a group of children designing screenshots for the mobile application and taking turns to look at the device.

Figure 5.1 Group of children designing mobile interfaces

5.2.4 Study Four

A researcher who had long-term experience in evaluation sessions with children and had been involved in (but not leading) some design studies with other researchers led the fourth study. For this study she was in charge of evaluating and redesigning a web game for a project on energy savings, as well as investigating children's knowledge of the game's topic. Like the previous study, this one was also focussing on 'improving' an already defined design with novel ideas while at the same time exploring the context of use. The researcher was therefore expecting to get from the session a deeper understanding of children's views on domestic energy, together with usability issues and some original ideas for alternative versions of the game.

The 16 children aged 12 worked in an ICT classroom for the 1-hour session. The initial plan was to first get the children to play individually with the game on the ICT

classroom computers before asking them to critically evaluate the game and design their improved version in groups of 3 or 4 children. Only when the researchers arrived in the class did they realise that the Flash® application was not installed in all the computers and therefore the game would not work properly. After a brief discussion, the best solution, given the time and technical constraints, was to get the children to take turns at the only computer that could run the game before starting their own re-design. Despite the initial inconvenience, the children managed to grasp important aspects of the original game and they reflected interesting ideas in their designs, showing what they were more interested in, especially with regards to the fun aspect. Some of the children's designs and graphics could be also used in the actual version of the game.

5.2.5 Study Five

The final study that was examined was led by a young researcher who had been involved in design for children for just one year prior to the session. The co-design session he was in charge of planning and coordinating was part of a bigger project involving Microsoft Surface® technology. The session was aimed at getting an initial sense of how children understood the pre-fixed gestures and controls on the touch screen interface and to discover if they could suggest interesting and novel controls that better suited their needs. For this reason this session fell in the 'envisioning' level of design, where the goal was to explore possibilities for an emergent and novel situation. Apart from providing an enjoyable and educational experience for the children, the researcher was concerned with allowing the children to design interaction styles for the surface technology and explore more innovative and desired interaction styles for surface technologies for children.

The session took place over a two and a half hour period, with a break in the middle. The group comprised 30 children aged 7 and 8. The children were divided into four groups, each having one facilitator. At different stages, the children were asked to design: a background or setting for a story or game; a set of characters; three objectives or 'things' that the characters must do to play the game; and finally, what must be 'done on the table' to make the characters do those things. To simplify the process, the interactive surface technology was described as a big touch screen – where characters must be controlled without the use of keyboard, mouse, controller etc. Although the children were shown an image of the Microsoft Surface Platform,

the comparative technology discussed was the touch-screen employed by the Nintendo DS® as the children had some familiarity with the technology.

5.3 Findings

The data gathered from each session were used to improve the understanding of how the different stakeholders involved in co-design sessions perceived the co-design experience. The aim of analysing these design sessions was to explore researchers' perceptions of the co-design practice and identify elements that are considered critical for the experience and therefore need higher attention during the session's coordination. The five studies were varied enough in terms of design focus to provide meaningful information on the variables that most influence the co-design sessions and are not limited to a specific design situation.

Hereafter the analysis of the feedback gathered from the researchers, the children, the teachers, and the observers is presented. This information served to define factors that determined the experience of co-design sessions and are presented at the end.

5.3.1 Researchers' feedback

As introduced in the methodology section (5.1.2 and 5.1.3) the feedback from the researchers was collected in different formats, i.e. pre-session questionnaire, research diary and a semi-structured interview after the session. The analysis of the information collected during the semi-structured interviews followed a Grounded Theory approach. Focussing on investigating practitioners' perceptions of the co-design experience, the interview conducted with the lead researcher after each study and before the following one helped to progressively identify aspects that were considered relevant for the experience by the lead researchers and refine the focus of the research.

The comments collected from the interviews with the lead researchers were transcribed and coded in order to identify clusters of the elements that influenced the experience according to thematic analysis. The themes were established with an inductive approach driven by the data themselves, without looking for specific categories (Braun and Clarke, 2006). The data were first divided into the two main topics of the interview, whether the information related to the *event of the co-design session* or to the *actual use of the DPD*. For the co-design sessions, the answers

focussed on: the description of the process; the perception of the success of the session; and finally the post-session reflections on success, failures or improvements. For the design structure, the distinction was amongst: the use the researchers made of it; the usefulness and easiness; and suggestions for improvements. In the following two sections I summarise the most relevant information collected first on the design sessions and on then on the use of the DPD that contributed to elicit common themes on what influenced the perception of success of the session.

5.3.1.1 Perceptions of the co-design sessions

All the studies gave different perspectives of co-design with children. Although with different design backgrounds, all the researchers were inexperienced in organising co-design sessions with children and all used the DPD, each having a slightly improved version of it, to assist their planning.

Study One. In the first study, the lead researcher claimed he got mainly two types of results he considered interesting: specific ideas that could be included in the design or useful insights on what children liked or disliked. However, the researcher believed that some of the ideas could have come from a brainstorming amongst researchers anyway, as he considered that children did not produce detailed enough ideas he could directly use in the design. However, a few of the ideas generated by the children did initiate a discussion amongst the research team after the design session, and eventually resulted in a suitable design concept.

Study Two. The lead research in this study reported to be disappointed by the session's outputs because the children digressed from the topic he set for them, which he later realised was not part of the children's curriculum. However, even if the content that the children produced was not so relevant for the game topic, he considered that ideas that children did come out with were interesting for the game play. The children easily drew their ideas but they struggled to write them down. He saw it worked better when he tried to summarise their ideas and wrote them down for them. For this reason, from his point of view it would have been more efficient if the children simply got to evaluate or add on to his own ideas of games. Thus, he concluded that 'generation type' activities did not really work with that age group, at least for the purpose of his design activity.

Study Three. The lead researcher in this study noticed that the templates she used for the design were not facilitating the production of screen design and storyboards as she expected; she also reflected that probably having more mobile devices available could have encouraged more relevant design ideas for the object. Not all the facilitators took notes during the session, but they did have a collective discussion amongst themselves straight after the session from which some useful ideas emerged.

Study Four. Overall the researcher was satisfied by the outcome of the session, even if she found the young teenagers less mature than expected. At the beginning, they struggled to take the tasks seriously and to focus on the content rather than only on the graphic aspects, especially when asked to critique the existing game. Apart from the actual designs, some of which were done with drawing programs on the computers, the researchers also valued achieving a good insight of the children's use of and expertise with games and technology.

Study Five. One surprising result for the researcher was that the children focussed more on the manipulation of the controls as opposed to manipulation of the characters. He related this finding to the fact that children's notion of controls are heavily influenced by the recreational technologies employed in their daily lives, as well as to awareness of context menus and object association. The results varied from group to group: a group got easily distracted and got into playful mood whilst not following the activity brief, while another immediately grasped what they were asked to do and produced interactions for the controls of the game characters they created. According to the researchers involved in the session, having fewer children per group and providing already made backgrounds would have helped the children to focus on the interaction styles.

From all these accounts of the sessions, each researcher differed in the predisposition they went into the session with, which influenced their perception of the whole session. Many comments from the researchers, especially in studies One, Two and Four, regarded the relation between what they would have liked to investigate and obtain from the co-design sessions and what did actually happen. For example, the researcher in Study Two who had already quite a strong position on what he wanted to obtain from the session ended up disappointed by not having his expectations matched. In most cases (studies One, Three, Four and Five) the researchers agreed

that the session helped to counter-check or overcome design assumptions. Overall, every researcher found some specific interesting contributions from the children, at either abstract or concrete levels, but some (researchers in studies One and Five) also felt that the most relevant ideas came from discussion amongst the researchers. Although finding the sessions with children useful, the researchers in studies Two and Four seemed to consider that the sessions might have been more productive if children's contributions had been directed more towards the details rather than abstract design concepts.

5.3.1.2 The use of the DPD

All the researchers went through the DPD before their design session: depending on time availability, they dedicated different amounts of attention and effort on it, with an average of one-hour dedication. The lead researcher in Study Five went through it twice and filled in all the boxes before, rather than after, the session. The lead researcher in Study Three skimmed it before the session to counter-check she was not missing out anything and went back to it afterwards to reflect on the experience. All the researchers found it quite clear and easy to follow, although each suggested some changes to clarify specific terms or simplify some of the tables. As a tool, it was used by all researchers as a validation of the plan they had initially in mind, helping to identify the design space and therefore refining design goals for the session. Rather than suggesting innovative ways of conducting the design session, the document succeeded in providing reassurance and endorsement for the researchers' own plan of the activities. The main flaws were found in the initial versions, with some apparently repeated concepts and with some steps where subtle differences were not detailed enough. The lead researcher of Study Three found it too long to go through according to her work schedule – she was actually quite familiar with design sessions in general and did not spend much time checking the details or looking at the references provided in the document – but affirmed it could be very useful for people who might have less experience in the field. The lead researcher of Study One, on the contrary, read it thoroughly and found the "what" section especially interesting as he was not aware of the wide array of techniques available and, with more time for planning, he would have liked to explore more of those. He also found useful hints that helped him to define what he wanted to get out of the session and clarify the objectives he initially had in mind. In general, all the

researchers agreed that the structure outlined in the document was helpful to position their design in a specific framework (the design scope and objective sections) and that it gave a sense of reassurance on their initial ideas and plans. All the lead researchers reported a willingness to use it again, mainly as a reminder of the structure to follow and also to share the details of the plan with the other facilitators. Upon reflection, the researchers agreed that the coordination amongst facilitators, mainly based on quick verbal communications, was not satisfactory and needed a more grounded common understanding of the design sessions. From the comments of the lead researcher in study Two it seemed that some of the problems he had with the session's outputs were actually dealt with in the document but were overlooked at the moment of planning. Examples of these included grouping strategies, suitability of the design content and feasibility of the communication channel. This problem suggests that these are important concepts that need to be more clearly expressed and their relevance emphasised.

5.3.2 Children's feedback

Children rated the fun they had in the co-design session on a smiley scale from awful to brilliant as specified in Appendix 5 and then described which was the best and the worst part of the session and related reasons. It has to be noted that each study concerned a different project and each comprised different design activities since the aim of this research was not to make a comparative study; therefore the results of each session were not comparable as in controlled variable experiments. However, looking at children's feedback, their ratings reflected a tendency to be more or less critical towards the experience in relation to the age (Hanna et al., 1997): 95% of the youngest children that answered the questionnaire (aged 7-8, as children aged 5-6 were not given the evaluation sheet) rated the activities as 'brilliant', while the two oldest groups (aged 11-12) had more evenly spread ratings from brilliant to awful, with the majority situated in the middle value of 'good' (57% in one group and 37% in the other). The middle group (aged 10-11) rated the activities between brilliant and good, with only 8% of the children giving a negative rate, which was 'not very good'.

Interesting qualitative information came from what the children considered to be more or less enjoyable of the sessions and the explanations they gave for their answers. They mostly enjoyed drawing and designing either games (as in study Two,

Three and Four) or specific parts of the application (as in study Five). The reasons they gave varied from being fun to being interesting, and they valued the chance to do something creative and different from their usual school activities. These results can be associated to the importance of children feeling empowered actors and enjoying being responsible for their design. Negative comments mainly related to occasional disruptions of the sessions (e.g. systems not working when technology was involved) or personal dislikes (e.g. having to write or give a presentation for children that do not prefer these activities).

5.3.3 Teachers' feedback

For studies Three, Four and Five, the researchers also collected teachers' feedback on what was considered to have worked well and not so well during the sessions. This information helped to have an idea of the teacher's perspective of the sessions. Not all the researchers in these cases extensively consulted the teachers beforehand about the content details of the activities; their main contact with the teachers and the school was to arrange the logistics. From the teachers' comments the aspects that they most valued were whether the activities positively engaged the children and at the same time were appropriate for children's level of abilities (study Five) and how well the activities fitted in the class curriculum (study Three). They only made two negative comments in studies Three and Four, concerning the organisation of the tasks when these failed to get the children's focus.

5.3.4 Observers' feedback

The same last three studies also obtained written comments from the researchers who were not directly involved in the planning of the session but who had participated as facilitators. Their feedback added information from a designer's perspective but with an external point of view. Their comments were more concerned with the design objectives and how these were met during the activities. In study Three, the perception of the session was quite different from one facilitator to the other: this may be due to their personal opinions but can also be ascribed to having dissimilar views on the actual session's plan and expectations, as it was reported that not much time was spent by the facilitators to brief beforehand. In study Five, the brief was very clear to everyone but their experience of the session varied widely as it was strictly related to the group of children they were in charge of. In all cases facilitators

noted the importance of providing concrete and easy instructions and examples to get the children to understand the task and focus on it.

5.4 Factors Influencing Co-design Sessions

From the analysis of the researchers' descriptions of the sessions and the other participants' feedback, common threads were identified on what participants perceived as a positive co-design experience. The recurrence of comments on similar aspects allowed the identification of aspects that are considered critical in the co-design sessions with children (emboldened in the following paragraph).

From the researchers' perspective, one of the main concerns regarded the correspondence between their **expectations** on the sessions and the actual outcomes. This aspect also emerged from the observers' comments, where having a different view of the session's objectives resulted in different perceptions of the session's outcome. The success of a session also depended in many cases on the different **practical issues** that needed to be resolved, some depending on the researchers' decisions and others from external circumstances (e.g. school's conditions). It also occurs that the session can be conditioned by **unexpected circumstances** that were not foreseen in advance and implied unwanted restrictions or improvised change of plans. In other cases the success depended also on the suitability of the selected design activities for the participating children, which also influenced the quality of the outputs. The importance of **children's perspectiv**e was also confirmed by teachers' and children's feedback. In the teachers' view, a successful engagement is imputable to the suitability of the activities to the children's capabilities, while in the children's view, it is attributable to the fun aspect and their personal preferences. Children's contributions are mainly not tangible results to directly include in the design; they are often insights on their world and ways of doing tasks that would trigger designers to produce suitable design ideas. Therefore, the **analysis of the session output** was often mentioned as a challenging aspect that requires skilled interpretation.

The most relevant aspects of the co-design with children practice can be then listed as: researchers' expectations of the outputs; children's perspective; practical constraints; unpredicted incidents; and the use of the outputs. Although these aspects were dealt with within different sections of the provided DPD, from the studies it

emerged that they deserve to be emphasised as they are considered decisive for a meaningful co-design experience. Hereafter, by describing in detail these aspects supported by quotes from the studies (researchers = Res, teachers = Tea, children = Chi), I highlight how they can be addressed in coordinating the sessions.

5.4.1 'Researchers' Expectations'

It is common to have expectations contradicted in co-design sessions, especially when conventional adult thinking is applied into children's worlds (Vaajakallio et al., 2010; Hemmert et al., 2010). To ground the planning of activities only on assumptions based on age suitability is an insufficient criterion, given the different communities of practice children belong to (Iversen and Brodersen, 2008) and their different level of exposure to technologies. In these five studies, most researchers were realistic in what to expect from the co-design session with children [Res04: "*Depends on your outlook. If you look for small things to contribute for design is very rich i.e. characters, things*"]. Some had very low expectations, and were therefore happy with the final outputs [Res01: "*Overall it did exceed my expectations – I started with low*"], others were too sure on what they expected to obtain and were left slightly disappointed [Res02: "*they mainly ended up with zombies and violence […] the problem with the output is the appropriateness of the design for the intended purposes*]. As highlighted by (Steen et al., 2011), people involved in organizing co-design sometimes fail to articulate precisely and realistically the specific benefits they aim to achieve. They ascribed a possible inefficiency of co-design outputs to this mismatch between the design goal and the session's expected benefits. Doing a pilot study before the session is a good practice but not always possible – having experts' advice or guidance on what is plausible to ask of a specific group of children can improve the definition of adequate objectives and can help designers in getting the most out of the results. In this respect, the DPD provided guidance on possible objectives and support in their definition.

5.4.2 'Children's Perspective'

The active engagement of children in the co-design session is necessary to achieve meaningful design outputs. This consideration is shared by practitioners of the field (e.g. Hall and Bannon, 2005; Guha et al., 2010; Sluis-Thiescheffer et al., 2011) but can be overlooked by novice researchers who tend to focus more on the design objectives and less on the suitability of the design activity for the children and the

interdependence of the two [Res02: "*I think I was asking something too difficult. They didn't know about the subject I wanted them to focus on and didn't produce useful outputs […] no, I believe I couldn't anticipate that*"]. Children's motivation and interest need to be high for them to engage in the design activities and therefore contribute with useful outputs (Mazzone et al., 2010). Therefore, when planning the session it is important to make sure that the right level of children's abilities, skills, attention and fun is addressed in the selected activities and correspondent techniques [Tea05: "*The activity was age appropriate and the materials produced were useful and colourful*"]. This level can be achieved by allowing the children to express their ideas by using different formats in variations of the activities or using props to introduce the activities, which are some of the ways to enhance children's engagement [Chi03: "*We got the chance to explore the phone*", or "*It gave us the chance to try design!*"]. At the same time, teachers or educational experts are other important references to consult before engaging the children to guarantee these levels are met, as well as for practical questions like behaviour management, distractions or grouping strategies to be controlled.

5.4.3 'Practical Constraints'

One of the constraints that most influenced the execution of the session is time. With a limited availability of time, many decisions regarding techniques to apply in the activities were restricted to the most familiar ones and these were not always the most appropriate for the specific design objective. Planning a design session with children often needs to involve expertise that is outside of the researchers scope and are therefore underestimated. In this category also fall the technical constraints, most of which are independent from the researcher's control and limit the range of possible activities. Communication within the research team and with schools helps to plan and coordinate the sessions effectively [Res03: "*not all of facilitators took notes, so I have to go through the children's design and maybe get back to the researchers for clarifications if needed*", or Res04: "*There is often a communication problem - normally there is a contact person but there should be more communication with the lead researcher*"].

The potential of a framework for this aspect is bigger in those situations in which the design session is more open to exploration, where the decisions on what to do can be made depending on the objectives rather than the constraints. A concise and visual

framework can be useful for when time for planning is short and detailed explanation are no longer needed, so that the options and variables can be identified at a glance.

5.4.4 'Unexpected Situations'

In all the studies there were some occurrences that were not planned for. They included technical failures or more conceptual faults, e.g. some technical equipment not functioning or the activity topic not matching the target group [Res02: "*At the end it didn't run according to the plan, there's always something that doesn't work according to the plan, so at the end we combined the two parts together*"]. Although some of these incidents cannot be foreseen, most of them can still be prevented. Some disappointing situations can be avoided by consulting with external experts, especially at the hosting school, both for practical and conceptual questions (Rode et al., 2003; Pardo et al., 2005). When extensive communication is not viable, having back-up plans ready is always an option. These aspects were easily overlooked in the overall planning. Therefore it is worthy to stress the importance of controlling foreseeable distractions and at the same time of allowing flexibility in adapting the modality to deliver the activities.

5.4.5 'Analysis of the Outputs'

In the analysed studies the results of the co-design sessions were mainly discussed informally amongst the facilitators that assisted in the session. These discussions amongst designers and researchers with different expertise are usually very productive especially because they are triggered by first hand insights on children's behaviours and perspectives ["Res01: "*On the way back from school we commented on what happened during the session and we came up with something feasible to design*"]. Apart from this inspirational value, children's contributions can also be analysed in a more formal way, requiring a thorough and time-consuming process. This process involves researchers interpreting and de-coding diverse outputs like drawings, writings, or low-tech prototypes, and possibly children validating the resulting design (Kelly et al., 2006; Sluis-Thiescheffer et al., 2011; Mazzone et al., 2012). The more abstract and creative the ideas, the harder they are to make sense of: this sort of ideas is likely to be more inspirational for the designers to develop novel design concepts (Hemmert et al., 2010). Detailed and concrete ideas are easier to see at a first glance and are more suitable to solve specific design problems. The DPD provided warnings that although children's contributions are invaluable inputs, they

are raw materials that need to be filtered through design principles and requirements before being translated into suitable inputs for the design. The analysis process starts with the identification of the session goals, where the type of output to collect is defined together with the way to collect it, which includes also specifying clear and simple instructions for the facilitators as well as for the children.

5.5 Summary and Conclusions

In this chapter the feedback and comments of participants of co-design sessions were analysed in order to complement the understanding derived from the review of the literature and direct experience in design projects. The five studies examined for this purpose gathered feedback from researchers (leaders and assistants), children and teachers, and identified five main themes: researchers' expectations; children's perspectives; practical constraints; unexpected situations; and analysis of outputs. These themes represent the factors shown to affect the experience of co-design sessions which therefore need to be looked at when defining the elements to involve in a co-design session. In Table 5.2 below I summarise the themes elicited from the feedback of the participants in the field studies and include recommendations on how to take them into account when planning or coordinating a session.

Table 5.2 Summary of the salient factors influencing the experience of a co-design session

Children's perspective	Can be ascertained by consulting with cognitive and educational experts (e.g. teachers, literature); Has to be considered in: grouping strategies, distribution of the activities in space, flexibility of timing of design tasks, by using appropriate techniques, variants of tasks and props, introducing fun elements, defining suitable and straightforward instructions; Has to be reflected in ethics of activities, data protection, risk assessment
Researcher's expectations	Are directly linked with setting the appropriate focus for the session; Can be adjusted by checking their suitability with experts on children's skills and potential; Can be better met if discussed and shared with the session facilitators
Practical constraints	Affect decisions on logistics: grouping children, distribution of spaces, timing of the activities, technical equipment
Unexpected situations	Can be limited by checking arrangements with person in charge beforehand; Requires high flexibility and adaptability of plans; Can be handled by having variants of design activities of different duration/resources
Analysis of outputs	Depends on the overall design scope and the specific session focus; Is subjective to facilitators/researchers' perspectives; Data interpretation depends also on data collection methods

These themes served to validate the elements compiled in Chapter 4 and complete the answer to RQ2 on the key factors that influence the experience of a co-design session. These elements are then applied in the definition of the framework presented in Chapter 6 as an answer to RQ3 on how co-design sessions can be modelled to ease researchers' practice.

6 CHAPTER SIX: TOWARDS A CO-DESIGN SESSION FRAMEWORK

This chapter presents a framework derived from the knowledge gained from this research as a support for reflective practice in co-design sessions with children. The framework seeks to answer RQ3 by presenting one of the possible ways to formalise co-design sessions with children and enable researchers to analyse and reflect on the practice's complexity. It is especially directed to inexperienced researchers, who can benefit from having references to the elements involved in the sessions and suggestions on how to address them. The following sections describe the first version of the framework (Section 6.1), the discussion around it with a group of practitioners (Section 6.2) and an improved version of the framework (Section 6.3).

6.1 Defining a Framework for Co-design Sessions

6.1.1 Organise the Elements of Co-design Sessions

The analysis of the results from the field studies presented in Chapter 5 allowed me to identify aspects that have an impact on the experience of co-design sessions for the participants (Section 5.4 in Chapter 5). To make sure that the multitude of elements to take into consideration in co-design sessions with children addressed these aspects, they have been mapped onto the sections presented in Chapter 4 (Section 4.3). Table 6.1 presents this mapping between the elements related to each of the five aspects as presented in Table 5.2 (researchers' expectations, children's perspectives, practical constraints, unexpected situations, and analysis of outputs) and the sections outlined in the DPD in Chapter 4 (the initial settings – including the design position, the session's objectives and identification of variables – and the five dimensions of the *Who-Where-When-What-How*).

Table 6.1 Mapping of the elements involved in the co-design sessions with children: the sections related to the planning of the sessions are in the columns while the five aspects that influence the co-design session experience are in the rows

	Initial setting	Who	Where	When	What	How
Children's perspective		Consulting experts; Grouping strategies	Spatial distribution of the activities	Duration of activities	Appropriate-ness of techniques; Variants of the tasks; Use of props	Ethics protocol; Straight-forward instructions; Fun elements
Researcher's expectations	Matching session's focus	Counter-checking with experts; Shared with facilitators				
Practical constraints	Availability of resources	Grouping strategies	Spatial distribution of the activities	Time planning		
Unexpected situations		Checking arrangements with person in charge	Foresee possible distractions; control	Flexibility of timing	Adapting tasks and variants	
Analysis of outputs	Addressing design scope and session's focus	Facilitators' perspectives				Depending on data collection; data interpretation

Fitting the elements into this table served to see how they relate to the sections identified for a co-design session in order to organise them into a framework. This relation is visually outlined as a conceptual model in the diagram presented in Figure 6.1. The model includes these key elements in the structure of the co-design sessions refined from the DPD on planning and managing a co-design session with children. On the top part of the diagram are the variables of the 'initial settings' (Table 6.1) that condition the decisions to take regarding the management of the session (the wh/hw dimensions), which are included on the bottom part of the diagram.

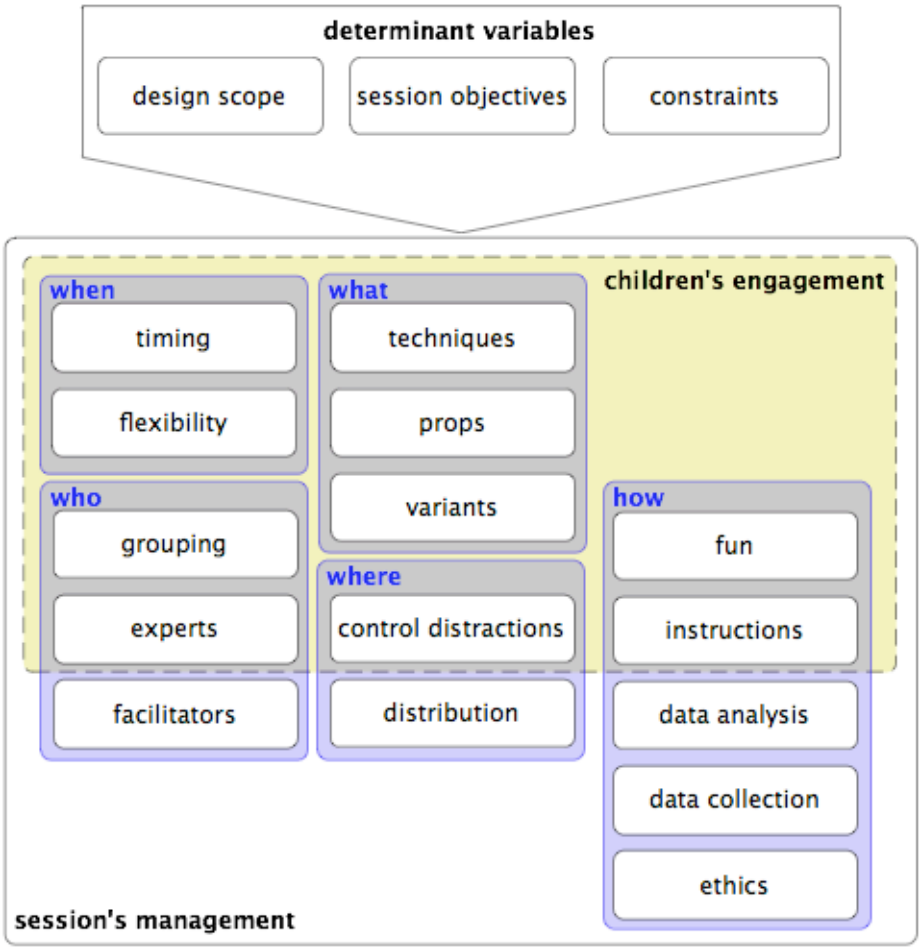


Figure 6.1 The model of the elements involved in a co-design session

The variables in the upper part of the model determine the condition of the design session by: defining the overall design scope as described in the DPD (from envisioning novel products to redesigning existing ones); selecting the session objectives (from understanding the context of use to generate design concepts); and identifying the existing constrains (e.g. availability of resources, external commitments).

Defining appropriate objectives for the sessions in concordance with the design goal is needed to optimise the value of the co-design session, as also stressed by Steen et al. (2011). Once the objectives and the available resources are defined, the decisions concern all those elements that will contribute to a smooth management of the session; these emerged to be important for the five main aspects outlined earlier. The *who-what-when-where-how* structure is encouraged as a simple-to-remember way to structure all the important aspects of the plan that would influence the session's output, in no particular order. Since children are the main focus, there is no 'children

box' as a single element for consideration, because children's perspectives need to be taken in the decision-making process for many elements. To emphasise the importance of engaging with children in the session, the elements that have to be especially considered for this aspect are grouped in the 'children's engagement' box. For example, the duration of the activities and the breaks in between have to be defined to optimise children's attention span, while the way to organise facilitators is only indirectly connected to children's engagement and depends more on practical issues.

6.1.2 The First Version of the Framework

The above model was used as a reference to develop a first version of the framework for co-design sessions with children (Appendix 9). Thus, the framework starts by providing support to define the session's objectives depending on the scope of the design project. By positioning their research, practitioners are enabled to set feasible expectations from the sessions. The framework v.01 presented in Appendix 9 includes a matrix derived from the model from Marti and Rizzo (2003) and differentiates the three possible levels of design scope (envisioning, supporting, improving) and the three main focus of the design activity (exploration, generation, evaluation) as presented in Chapter 4. This differentiation serves as the setting for the general design scope and guides the selection of objectives and techniques for the specific co-design session.

The second set of factors to consider for the sessions are the external constraints (in terms of availability of time, spaces, technological equipment, participants or project specifications to stick to) that limit and affect the selections of the related resources and decisions to take for the planning. Table 2 presents the elements to take into account before starting planning the session and the different options available.

Table 6.2 Initial settings

Design scope
improving / supporting / envisioning
Session focus/objectives
understanding the context of use / generate abstract or concrete ideas / evaluate ideas
Constraints
– participants (children / facilitators / stakeholders)
– resources (time / places / technology)
– project specifications (content / target / schedule)

Once the objective and the constraints are identified, the rest of the variables can be defined based on those and the session can be planned.

Following the *Who-Where-When-What-How* format, Table 6.3 lists the different roles each participant can take in the design session for the *Who* section. References to cognitive, physical, social and emotional skills of children need to be considered whenever decisions need to be taken, for example, on time duration, activities to perform, materials to includes, or work groups to arrange (Sluis-Thiescheffer et al., 2011). When deciding on the children's role, the way to group the children (in the case of group activities) is a variable to consider, apart from age, skills and cultural background.

Table 6.3 *Who* section

Children
– age / skills / socio-cultural context / community of practice
– group dynamics
Teachers
– informants / participants / guardians / spectators
Facilitators
– active / passive / neutral / informed / observer
Stakeholders
– parents / clients / developer

Table 6.4 illustrates the options of places (*Where* section*)* in which the session can take place, based on the familiarity for children, and identifies the characteristics

related to each. Different ways to distribute the activities in the spaces are also considered in this section.

Table 6.4 *Where* section

Children's places (school – home)
– familiar / distraction / interruptions
External places (lab – museums – others)
– semi-controlled / unfamiliar
Distribution (linked to grouping)
– all in one room / different dedicated rooms

Table 6.5 refers to the W*hen* section and all the factors involved with the timing of the session, from the overall duration to the single task length and the breaks in between. Considering flexibility when planning the timing of the session is a way to be prepared for unpredicted circumstances.

Table 6.5 *When* section

Timing
– duration of session
– duration of single task
– breaks and transitions
– flexibility to adjust to unpredicted events

Table 6.6 relates to the selection of the design activities and refers to the technique table (as in Chapter 2). In this section it is also advised to prepare alternative activities for possible unexpected changing conditions.

Table 6.6 *What* section

Techniques
– wide variety of activities
– depend on all previous variables (Time, materials, objectives, participants, constraints)
Back-up plan
– extra/alternative activities

Finally, the *How* section in Table 6.7 considers the elements related to ethics, aspects of children's engagement, ways to brief the activities and to collect suitable outputs for the analysis. In this section there is also a reminder to pilot the study.

Table 6.7 *How* section

Ethics
– safety / privacy / voluntary
Engagement
– motivation / fun / suitability
Instructions
– concrete / specific / triggers /props / apt
Outputs
– understandable / record during and post-task / realistic expectations
Pilot
– mock-up session to test how the selection of different variables work in reality

6.2 Group Discussion on the Framework

This version of the framework was presented to a group of six design researchers with different backgrounds (psychology, web design, computer science, social media) and no experience on designing with children, except for two who were two of the lead researchers who had participated in the previous field studies and therefore had already some experience on the practice. All of these researchers were part of a research project that had just started and that required them to arrange co-design sessions with children. Therefore they all were interested in learning and sharing an understanding on how to handle co-design practice with children.

6.2.1 Procedure

The six researchers were given an introductory talk on designing with children and presented with the relevant elements involved in it by following the structure of the framework described in Section 6.1.2. The researchers were then divided into three work pairs in order to draft a plan for a possible co-design session for their research project. The specific research project they were working on aimed to improve teenagers' awareness of and behaviour towards energy consumption. The researchers were paired according to their level of expertise in the practice of co-design with children, based on their previous experience in organising and managing co-design

sessions with children and the derived level of confidence in planning a strategy for action (as defined in Chapter 1, Section 1.3, based on the discussion around Dreyfus's (1982) model).

There were two 'inexperienced' pairs and one 'experienced' pair. One of the 'inexperienced' pairs was given a document with the structure of the framework, while the other pair had no material provided. The third pair of researchers were the 'experienced' researchers and these were also not provided with any material. Table 6.8 illustrate the conditions of the three pairs. The pairs had only one hour to discuss and draft their session plan before a plenary discussion.

Table 6.8 Distribution of the pair of researchers for the session planning (according to their expertise in co-design with children and the use of supporting material)

	Inexperienced	**Experienced**
With material	Pair 1	
Without material	Pair 2	Pair 3

6.2.2 Results of the Collective Discussion

Pair 1 – Inexperienced with Material. This pair started off by following the order of the structure provided, from the objective to the task, and then shuffled the pages around (corresponding to the *Who-Where-When-What-How* sections) when getting to the stage of deciding the elements and variables to employ. What they found most challenging, having no previous experience, was getting the right timing and the right distribution of children for the tasks. They stated that they would rely on the teachers to check the appropriateness of the plan. Another concern they had was to come up with engaging activities without being biased by the most commonly known activities (e.g. paper prototyping): they reported that having prompts on different methods that are available would be of help. Some of the activities they suggested were taken from the ones previously presented in the seminar, (role-play and Blind Man's Bluff) which were considered novel and interesting for them.

Pair 2 – Inexperienced without Material. This pair started by defining the age group of the children to engage in the session and then divided the session in different parts, from an introduction of the main theme, to an initial brainstorming session and finally to acting out in physical scenarios. For each stage they suggested that they

would modify the grouping of children to avoid biases and encourage generation of new ideas. The part they found most challenging was to think of a way to engage the children in an active way and at the same time make sure that the ideas were all written down and not lost. They reported that they would refer to experts and teachers to get help with their doubts and would aim to run a pilot before the session. They commented that they struggled with structuring the session and getting all the variables in place. One of them claimed: "*it would have been nice to have something written down*" as to having had some structure to follow during the planning.

Pair 3 – Experienced without Material. These researchers started to decide on the practical issues, like the duration of the task and the age and number of the children, and then they started thinking about how to present the context of the topic and about what information they would want to collect from the children. What required most effort for them was to think of a way that was exciting and engaging for the children and at the same time was providing useful information for the design. They would have liked to have access to a database of previous sessions' outputs and see examples of how that information has been used. Regarding the availability of a support tool, one of the researchers considered "*it was useful to have prompts* [as in the previous field studies]*, then you could see if you were using the right method, or have better ones suggested*".

6.3 The Chi-Co-S (Children Co-design Session) Framework

This plenary discussion with the researchers confirmed the relevance of the five aspects of co-design session with children derived from the field studies (researchers' expectations, children's perspectives, practical constraints, unexpected situations, and analysis of outputs) and the call for a support tool, mentioning several purposes. They mainly valued the possibility to have some assistance in making decisions about time, activities, grouping strategies. Simply listing the options of the elements that need to be decided (i.e. children's roles, space distribution, grouping possibilities) was useful to make sure that the elements were taken into account but they would still leave uncertainty on how to take the decision. Since each design situation is unique and depends on many variables, there is not a unique right way to decide for each element of the session that applies to all the cases and can be outlined as a guideline. For this reason, the framework was refined by adding short

explanations on the implication each element will have in the experience of the session. In this way, the decisions each researcher has to make according to each specific design situation are supported by concrete considerations of the effects that each option may have on the experience of the session and possible outcomes.

In this new version of the framework (as in Appendix 10) the WH/HW structure is kept and a *Why* section is added to include the design scope and session's objectives (Table 6.9). Adding this dimension in a table format gave more consistency to the framework while emphasising the importance of defining the design goal and consequently appropriate session objectives before deciding on the other dimensions.

Table 6.9 Elements of the *Why* section

WHY		Design scope		
		Improving (re-design of existing products)	Supporting (design a new way to support a well-known activity / solve an existing problem)	Envisioning (Envision novel situations of use and future technology)
Session's objective	Context exploration (retrieve information on context of use)	Investigate the use of existing technology	Explore context of use and related activities	Reflect on context and values
	Concept generation (generate concepts or ideas)	Re-design technology	Generate novel solutions for defined requirements	Define possible concept scenarios
	Evaluation (test and validate earlier solutions)	Evaluate improved usability	Evaluate satisfaction of user needs and design requirements	Evaluate high level/abstract concepts

Each of the other five sections are presented as a table suggesting pros and cons of what each element may imply for the design session (see Table 6.10-14 below). By referring to these tables, practitioners are supported in decision-making for defining their plan of the sessions.

The *Who* section (Table 6.10) includes considerations of experts, facilitators and children grouping strategies together with the different implications each decision may have on children's performance.

Table 6.10 Elements of the *Who* section

WHO	Pro	Cons
Experts	**Support the definition of suitable activities**	
Pedagogues	Advise on suitability of activities for children; feasibility of expected results; behaviour management; specific children's skills (Teachers can cover this role for schoolchildren)	May clash with design perspective
Domain	Ensure appropriate focus on the subject topic	Risk of digress from design objective
Grouping	**Grouping strategies have impact on the results and need to be accounted for in the outputs' analysis**	
Individually	Allow original ideas; Easy to follow and collect data	Children may find it difficult to start off or be inhibited by power relations
Groups	Provoke discussion and chain of ideas; Reduce time and facilitators/child ratio	Leaders may take over more introvert personalities and limit outputs' variety; Copying and imitations may need to be normalised when analysing the results
Facilitators	**Share the same approach on the activities, understanding of their role, of the activity goal (and of the expected output)**	
Observers	Record what happens during the session; take care of logistics	Risk of observers' effect
Assistants	They support children in the tasks, providing prompts rather than solutions to problems	They may influence children's ideas and/or their interpretation of the activity

Possible sources for distractions are presented in the *Where* section (Table 6.11), together with the space distribution: children in the same room, all doing the same activity simultaneously, or doing different activities, or a dedicated space for each activity.

Table 6.11 Elements of the *Where* section

WHERE	Pro	Cons
Distractions	**Control possible distractions related to different contexts**	
Familiar context (e.g. school, home)	Children can feel at ease and in control, facilitating focus on the task	Children can be distracted by routine activities or external interruptions
Unfamiliar context (e.g. lab)	Children can feel more focussed as in a monitored setting	Children can be uncomfortable or attracted by new things they see around - if the space is not accurately set
Distribution	**Where to allocate the activities**	
Isolated (one activity per space)	Better control of the activities by the facilitators	Needs more time and/or more facilitators to reach a large number of children
Joined (more activities in the same space)	Needs less resources	Increases risk of chaos and distractions; Needs more coordination

For the *When* section (Table 6.12), options are presented for time management and planning for flexibility.

Table 6.12 Elements of the *When* section

WHEN	Pro	Cons
Timing	**Manage time resources**	
Duration	Adapted to children's attention span and activities' goals	May need to be adapted to external constraints
Breaks	Allows for task shifts and children's rest	Interrupt the flow of the activity
Simultaneous (in different or same space)	More activities running at the same time can get more output in less time	More difficult to manage; Need more facilitators
Flexibility	**Having back-ups of activities of different duration**	
Variations in duration	Allows for adapting to children's changing needs or unexpected events	Can jeopardise analysis and comparison of outputs

The *What* section (Table 6.13) includes a table with a list of the most common techniques used in co-design session for children (informed by ETR Associates (2007); Jensen and Skov (2005); Sluis-Thiescheffer et al. (2011)) listed in

alphabetical order, as presented in Chapter 2 (Table 2.1). Each technique has a brief description of its intended aim and its relation to the different design activities of exploration, generation and evaluation. In addition, for each technique, the table provides some examples of possible variations, the design stage of application, an indication of the required children's skills, and a summary of the pros and cons of its employment. The list of available techniques available cannot be exhaustive but it did aim to cover most of the different techniques from which the design activities can take inspiration.

Table 6.13 Elements of the *What* section

WHAT	Pro	Cons
Techniques	**Refer to the table of techniques to define the activity**	
Variants	**Having back-ups of activities employing different modalities**	
Use of different expressive channels	Allows children to express themselves in the preferred way (e.g. text, drawing, talking, making, acting)	Need more time for analysis and comparison of outputs
Props	**Use of materials or technology to support the activities**	
Reference to concrete objects or examples	Help focus children's attention	Can bias the results if not tested beforehand

The *How* section (Table 6.14) starts with ethics, follows with tips on the different ways to brief the activity and ends with a discussion about data collection. This last point is directly related to the analysis of outputs, which is essential to determine the session's success. For example, the interpretation of children's outputs afterwards can be difficult and imprecise, and so indicates a need for the proper collection of data and children's explanations in the moment.

Table 6.14 Elements of the *How* section

HOW	Pro	Cons
Ethics	**Consent, Safety, privacy, freedom to drop out**	
Data collection	**Affects the way outputs are understood and interpreted afterwards**	
Video / audio recording	Provides evidence for later analysis	Time consuming to analyse; Risk of observers' effect
Pictures of children's outputs	Provides evidence for later analysis	Need children's explanations or contextual notes for interpretation
Presentation of ideas	Gives children a sense of completion and researchers information on the outputs	Some children do not like to talk in public
Progressive	Record the building of ideas and gives insights to children's way of thinking	Time demanding
Instructions	**Brief of the activities to complete**	
Use of examples	Concrete references that are familiar to children and they can refer to in order to understand what they are expected to do	Can influence or bias their outputs
Use of triggers	Having visual clues or triggers may facilitate the setting off and focus during the activity	Risk of digression from topic
Fun	**Including engaging elements to the activities**	
Introduction of fun or entertaining elements	Increase engagement of children in the activities	Need to be controlled to avoid distraction from topic
Data analysis	**Interpret and analyse session's outputs**	
Reference to objectives	Focus the analysis of the outcomes	Risk of limiting new solutions
Multi-disciplinarity	Allows interpretation of outcomes from different perspectives apart from design implications	Need more coordination and communication
Iterative process	Allows evaluation and refinement of results	Time consuming

The aim of this framework is to support novice practitioners in reflecting on the implications of each element when taking decisions during the outlining of a detailed plan of their session. For example, if researchers want to involve children in the design of a computer game on a specific topic, they would check with the teacher or pedagogic expert whether that topic is suitable for the selected group of children to work on, and if that is not the case, either look for a different group of children or adjust the topic to the available group. In a different example, if researchers are looking for a wide range of inputs in a limited time, they would consider organising a

session with a whole group of children and recruiting several assistant researchers to record the outputs rather than having small groups of children at a time in a dedicated space to explore a topic in depth.

6.4 Summary and Conclusions

The results from the studies described in Chapter 5 served to integrate previous knowledge on the practice (derived from literature and my direct experience) and to identify five critical factors that were considered to be determinant in co-design sessions with children: setting the right expectations; adopting the children's perspective; managing resources constraints; avoiding unexpected situations; and collecting and analysing outputs. With this perspective, an initial version of the framework to support novice practitioners in co-design with children was developed. This framework has been presented to a group of 4 inexperienced and 2 experienced researchers and opened a plenary discussion with researchers on a specific design. This discussion around planning a design session with children confirmed the importance of the five dimensions (*Who-Where-When-What-How*) and also the convenience of having practical references to assist the planning of the session. For this reason, the framework was refined in order to include prompts for reflection as an aid in a co-design session. Highlighting advantages and disadvantages (*Pro* and *Cons*) of the different options related to each element was added as a support for researchers in taking decisions about the elements to involve in the session without constraining possibilities. Therefore, the framework answers RQ3 on how the co-design session with children can be formalised by presenting a way to model the sessions that includes all the aspects identified as important from previous research. At the same time the framework provides an answer to RQ on how researchers can be enabled to run co-design sessions with children as it points out critical aspects that are useful for coordinating design sessions.

7 CHAPTER SEVEN: CONCLUSIONS

This chapter draws conclusions on the research reported in this thesis by: summarising the whole process of the research, from its rationale to its results (Section 7.1); answering the research questions posed in Chapter 1 (Section 7.2); and listing the major contributions to the field (Section 7.3). Limitations of the research are presented in Section 7.4, while directions for future work (Section 7.5) depict possible ways to develop the research further and overcome some of the limitations.

7.1 Summary of the Research

The involvement of users in the design process is a debated practice in the HCI community: on the one hand including users' perspective in the design of products intended for them enhances design outputs with improved usability, users' needs satisfaction and product acceptance; on the other hand it can slow the process, due to adding costs in terms of time, resources and coordination needed for organising the sessions, running the activities and analysing the inputs from the users (Poltrock and Grudin, 1994; Kujala, 2008; Steen, 2008). When the collaboration of users with designers is applied across the whole design process as in co-design practice, both costs and benefits increase. For the benefits of co-design to overcome its costs a thorough definition of the design goals against which to align the possible useful results from the co-design activities (Steen et al., 2011) is needed. At the same time, Steen (2011) also recommends that the design researchers or practitioners in charge of arranging the activities need to be aware that the definition of the objectives and the selection of methods or participants can significantly affect the design process and its outcomes. Therefore, it is critical to define the appropriate stage of the design process to include these activities, the adequate role to give to the users involved in the activities, and the suitable co-design techniques to engage those users.

In the context of design for children's technologies, the practice of involving users in the design process since the early stages is considered crucial to understand their needs and to shorten the gap existing between adult designers and children users (Druin, 1998; Markopoulos and Bekker, 2003; Nesset and Large, 2004). By involving them in co-design practices, designers can better understand their needs and meet their requirements. A caveat when doing co-design with children is that children are in continuous physical and cognitive development and this affects their

perception of the world, their interaction with the context and their communication with others (Piaget, 1952; Papert and Harel, 1991; Ackermann, 2004). These conditions imply additional variables to take into account when defining the appropriate objectives of the co-design session, selecting adequate techniques, participants and settings, and interpreting the results.

The research in the field identified a need for guidance and directions for designers and researchers who want to organise and conduct useful participation of children users in the design process (e.g. Nesset and Large, 2004; Good and Robertson, 2006; Woodcock, 2008, see Chapter 2, Section 2.2.6). The discipline of HCI has been often criticised for needing more focus on providing an effective scaffold for creative design practice in concrete situations, by going beyond guidelines (e.g. Lieberman, 2003; Greenberg and Buxton, 2008). Following Schön's (1983) directions on preparing practitioners for the design process rather than guiding them through it, the research effort described in this thesis takes a reflective approach on the design practice intended as complex activity of inquiry and action (Stolterman, 2008). The framework resulting from this research aims to provide support for design practitioners who embark on co-design sessions with children by providing an understanding of the practice and its implications.

With these premises, the aim of this thesis was to explore a way to ease the organisation of co-design sessions with children for researchers with little experience in this design practice. As discussed in Chapter 1 (Section 1.3), practitioners can differ in the expertise they have in making appropriate strategies for action when analysing novel or complex situations. By providing support for reflection on aspects to decide on when planning a co-design session, the framework can be useful for non-expert practitioners but can also be an aid for experts by helping them not to overlook relevant variables due to excessive confidence. The research followed a design research process, with the emphasis on the exploration and investigation of the context of the co-design practice with children rather than on design development (Ellis and Levy, 2008). The thesis reports on the development of the research process, from the investigation to the definition of the framework.

Drawing knowledge on the practice from the review of the literature and from direct experience in the field, an initial structure of co-design sessions with children, that

included all the elements implied in it, was defined. The working document (DPD) derived from this structure was consulted by novice practitioners when coordinating co-design sessions with children in field studies. The analysis of these design sessions and the perspectives of each participant in the experience gave additional information to deeper understand the factors that most affect the outcome of the co-design practice, i.e. setting the right expectations, adopting children's perspectives, managing resources constraints, avoiding unexpected situations, and collecting and analysing outputs. In order to organise the elements of a co-design session that can address these factors, a first version of the framework was defined and discussed with a group of researchers with mixed expertise in co-design with children and was then improved further. The resulting Chi-Co-S framework (Chapter 6, Section 6.3) is conceived as an aid for practitioners to reflect on the implications that each element implied in a co-design session with children has on the outputs of the session. In this way researchers are assisted in taking decisions when planning and coordinating co-design sessions in a flexible way that can be applied to different design situations.

7.2 Answers to the Research Questions

The research process followed throughout the thesis progressively provided answers to the three sub research questions and led to answering the main research question as detailed in the following sections.

7.2.1 RQ1: How can the complexity of the co-design practice with children be broken down?

By considering the co-design practice as a complex activity of actions and exploration, the research aiming at supporting it needs a deep understanding of it, as Stolterman (2008) argued with regards to Interaction Design practices. A design research approach was adopted for gaining this understanding towards achieving a suitable support of the practice. Therefore, the answer to this first question started with the investigation of the research domain, by analysing the wider design context and foundations in which the co-design practice belongs (as in Chapter 2). The review of different positions around the costs and benefits of users' involvement in design processes highlighted the strengths and weaknesses of the practices and suggested possible solutions to overcome difficulties in its application. At the same time, direct experience of the practice through exploratory studies and design

projects (as in Chapter 3) provided a first hand insight of the practical matters implied in co-design sessions. The synthesis of the knowledge acquired around the co-design practice with these direct and indirect investigations helped in separating all the different elements that are involved in a co-design session with children and led to breaking down its complexity. By going through the three stages of before, during and after a co-design session (as in Chapter 4) it was possible to make connections between the elements and see how they intervene in each step. The result of this first part of the research was the definition of two lenses that were used to decipher these relevant elements: the management of the session on the one hand, which includes the design focus, the coordination of the facilitators, the organization of practical arrangements, the methods used to collect and analyse the data; and the engagement of children on the other hand, which comprises the selection of appropriate techniques, the coordination of children's participation, the use of fun elements and varied formats.

7.2.2 RQ2: What are the key elements and factors that influence a co-design session?

A first answer to this question has been given in Chapter 4 (Section 4.2.2), with the definition of the two perspectives used to group the elements involved in co-design sessions with children, the management of the session and the engagement of the children. The answer to this question has then been completed with the results from the studies described in Chapter 5. Investigating the perspectives of the participants of the co-design sessions (practitioners, facilitators, children and teachers) served to identify five main factors that were salient in determining the output of the sessions. Amongst these factors are:

- researchers' expectations - that need to be aligned to realistic objectives of the session;
- children's perspectives - that have to be taken into account when selecting the design activities in order to achieve participants' engagement;
- practical constraints - that limit the possibility of options and have to be counterbalanced to make sure the design objective can be met;

- unexpected situations - that have to be limited by gaining knowledge of the settings circumstances and planning for flexibility and adaptability;
- analysis of the outputs - that is related to the clear definition of objectives and the way data are collected.

Each of these factors can be conditioned by the elements described above in the management and engagement perspectives. Relating the elements into these five factors (as in Table 6.1) served to identify their relevance in the co-design session and their role in the framework derived from it.

7.2.3 RQ3: How could co-design sessions with children be modelled to ease researchers' practice?

Having identified all the elements that make up a co-design session and having defined their role helped to outline a structure of the session intended to support practitioners when planning one. This outline, illustrated in Figure 6.1, comprises two main parts: a first block with the variables that determine the decisions to take to arrange the sessions, i.e. the design scope, the session objectives and the constraints; and a second block in which the elements are grouped in relation to the decisions that have to be taken regarding the what (i.e. techniques, props and variants), the when (i.e. timing and flexibility), the where (i.e. distribution and distractions) and the how (i.e. fun, brief, data collection and analysis, ethics) of the session. This outline fed the definition of the Chi-Co-S framework (described in Chapter 6), which followed a *Why-Who-Where-When-What-How* structure, including the definition of design scope and objectives before pondering all the variables in the other dimensions.

7.2.4 RQ: How can researchers be enabled to run effective co-design sessions with children?

The answers to the three sub-questions described above contributed to answering the main research question. The Chi-Co-S framework derived from this research and presented in Chapter 6 (Section 6.3) is a way to support researchers in coordinating co-design sessions with children. The framework provides this support by introducing aspects that are relevant for a co-design session and informing on the possible impact (listing pro and cons) each element may have on the outcome of the session. An accurate definition of objectives and selection of techniques, participants

and resources for the session contributes to optimising the benefits of the co-design practice with respect to the effort invested, as suggested by Steen (2011) and in line with the results of the analysis of the field studies reported in Chapter 5. Therefore, by being supported in the process of defining and organising the co-design session, the practitioners can achieve results that are better aligned with their goals and useful to their design. Hereafter I describe a hypothetical scenario that illustrates how the framework can be used in practice.

> Yvonne is a graduate researcher in Interaction Design. She is involved in a design project aiming at developing a science application for a digital tablet device for children aged 9-10. The project design team decides to involve children in the process to better understand their needs and define the requirements for the application. Yvonne is in charge of organising the design activities with children. She has participated in Interaction Design projects but has never worked with children following a co-design practice. She uses the Chi-Co-S framework as an aid in taking decisions on how to arrange the co-design session. She starts with the *Why* section by identifying the purpose of the design project and what stage it is at. Since the project is about developing a new application for a digital tablet, the design scope is closer to the 'supporting' level, i.e. designing a new way to support an existing activity (educational), in this case on a specific subject (science) and with a specific technology (interactive tablet). Given the different aspects to design for the device (i.e. the interaction, the visualisation and the content), she decides she first wants to focus on interaction modes. In the same section she is prompted to specify the session's objective: as she has already investigated possible interaction modes of children for touch screen and similar technologies, she chooses to involve children in the generation of concepts. This step leads her to envision what she wants to get out of the session in order to decide the best way to achieve it.
>
> In the *Who* section she has to define the participants. She starts making contacts with local schools to find a suitable group for the project requirements that has interest and availability in participating in the co-design sessions. She meets the teacher responsible for the class in order to introduce her to the purpose of the design session and at the same time start gathering useful information for planning the session. The teacher comments that her class is quite a diverse group, generally very active and enthusiastic, with a couple of students who are particularly disruptive and a few that stand out for their intelligence and motivation, being sometimes quite challenging. She then provides details of the availability of times, spaces and resources the school can offer, so Yvonne can adjust her plan.
>
> Back in her office Yvonne takes the *What* section and goes through the techniques table in order to find an adequate way to engage the selected children and gain useful outputs. She scans the list of techniques pausing on the ones that are suggested for 'generation' design focus. She opts for combining prototyping techniques with body-storming and storytelling, given that children of that age would have quite developed linguistic and spatial intelligence, according to the application of Gardner's multiple intelligences to design techniques (Sluis-Thiescheffer et al., 2011). The children will first have a go on the interactive tablets to familiarise themselves with the basic interaction and then move onto paper and cut-outs to focus on stories and actions. They will use buttons to simulate blood cells going around the human body, draw the different elements of the environment

and perform the bi-dimensional movements for the different actions. By doing so, Yvonne aims to see ways in which children understand 2-D movements and collect interesting ideas for her science application.

In planning the tasks she goes back to the *Who* section for deciding if the activities would be individual or in groups. She sees group activities generate more ideas but since the design is about tablet devices that will not allow many users to interact on the same item, she opts for children to work in pairs. In the *Who* section she is also warned she has to arrange the presence of enough facilitators to assist in the session and record the activity in detail. The class she will be working with has 26 children, which makes 13 pairs. Even if one facilitator could be following two pairs at the same time, she realises she will struggle to find 6 researchers available. To find alternative solutions, she looks at the other variables in the *When* and *Where* sections and considers splitting the session in two parts, having half of the children first, all in a big room, and the other half just after, which will reduce the number of facilitators helping in each session to three.

The plan is then checked with the teacher, confirming she agrees on the distribution of time, children and spaces. As suggested in the *Who* section, she also presents the specific tasks to the teacher, who suggests modifications to introduce the topic in a more familiar way for the children that will increase their potential engagement in the activity. To finalise the details of the plan, Yvonne uses the *When* section to define the time for each stage of the task, making sure they will fit in the one hour slot, including the introduction and the debriefing. In this section she realises the activity needs to be able to be scaled for possible changes of the agreed circumstances, especially because her session is scheduled right after the mid-morning break and she can foresee likely delays.

Finally, as for the *How* section, she prepares the consent forms to send to the parents on time to have them signed before the event. Having discussed the plan with the teacher makes her feel confident with the suitability of the tasks and the brief to present to the children. What is left to organise in that section is the way the data are collected. As the ideas she is asking to represent imply movement, she will bring a video camera to record the presentation of the interactions children come up with, while the facilitators will follow the progress of the ideas children will be developing in each pair. A couple of days before the session she meets with all the facilitators and shares the final details of the plan as suggested in the *Who* section, making sure everyone is clear on the goal of the activities and their role.

The above fictitious example shows an ideal use of the framework to support design practitioners in developing a strategy for co-design sessions with children. The use of the framework was not in following a specific order or route but rather as a reference that highlighted the aspects that need to be thought of.

7.3 Contributions of the Research

This thesis contributes to the discussion around co-design practice, providing props for reflection for practitioners. The specific results of the research that can be used to this purpose and detailed in this section are: the collection of co-design techniques, a

list of lessons learnt from direct and indirect research in the field, different ways to structure the elements implied in a co-design session and the Chi-Co-S framework.

7.3.1 Collection of Techniques

The analysis of the different techniques applied in co-design with children and of the different criteria used to classify these methods resulted in a collection of techniques to use in the co-design practice. Table 2.1 in Chapter 2 collates the result of this research by giving an overview of the possible techniques to employ in co-design sessions with children and a combination of criteria relevant for the co-design practice. As every design project has specific characteristics, techniques always have to be adapted and applied in different ways. Therefore rather than describing the techniques' procedures, the table provides references to existing applications of some techniques and their variations. With the specific purpose of supporting practitioners in selecting and defining their activities for the co-design session, the table also provides indications on suggested design stages, advantages and disadvantages of their application, and the preferred skills required from children to execute them.

7.3.2 Lessons Learnt from the Literature Review and the Research Projects

The review of the literature around the practice of co-design within the User Centred Design domain (described in Chapter 2) identified relevant aspects with regards to co-design sessions with children. These lessons learnt from indirect research have been complemented with the insights derived from direct research in the field presented in Chapter 3 to gain a deep understanding of the co-design practice. This understanding has been used as the starting point for the development of the framework. The complete list is compiled in Appendix 1 and can be summarised in the following points:

- Processes of UCD and ID do not imply a prescriptive set of steps. These design approaches are based on shared principles such as: the importance of considering users' needs, iteration of analysis, design and evaluation stages, and some degree of involvement of users in the process;
- Co-design is a useful practice to get users' real insights and design more user-centred products but relies on designers' ability to conduct the studies and analyse the results;

- Most researchers advocate a balance between activities with children and reflections and analysis of designers in the overall design process – as in informant design
- Age, physical, cognitive, and emotional development, cultural and social background, community of practice, are all important variables that influence children's capability to interact with technology and to participate in co-design sessions
- The variety of competencies of the different participants of co-design sessions with children (facilitator, children, experts) have to be clearly identified in order to define their role in the process and optimise the value of their contribution
- Decisions on each organizational aspect of the co-design session (e.g. distribution of participants, spaces used, techniques applied, materials employed, time allowed, information recorded) have an impact on the overall outcome
- Considering how to engage children in the activities benefits the outcome of the co-design session. This engagement can achieved by using a variety of communication channels to allow children with different intelligences/abilities to express themselves, employing prompts of different format (e.g. video, music), and including variation of an activity (i.e. same goal but different ways to achieve it)
- Planning for flexibility in terms of formats, resources or time used for the activities helps deal with unpredicted changes in the circumstances of the sessions that can otherwise jeopardize their outcomes
- Identifying realistic objectives of the session is needed to define the design activities and the sought outcomes while having an open mind allows the researcher to embrace novel and original results.

7.3.3 The Structure of a Design Session

The process of developing the framework starting from the investigation of the field went through different stages that implied de-structuring and re-structuring of the co-

design practice. During this progress, different ways of organising the elements implied in the practice were deployed. The first one (in Chapter 4, table 4.1) followed a chronological categorisation of before, during and after session stages. The following one (tables 4.2 and 4.3) adopted the two points of view of the researchers and the children, the first one concerns the management of the session, and the second one has to do with the engagement of the participants. The combination of these models led to the structure of a design session that considers the two perspectives of management and engagement throughout the planning of a session. In this model, depicted in Figure 4.1 in Chapter 4, the 'before' moment concerns the definition of the design scope and session objective together with the identification of resources available. These factors are the ones that will determine the elements to organise for the session that are grouped according to the decisions to take concerning the 'who', i.e. children and facilitators; the 'where', i.e. the spaces in which it takes place; the 'when', i.e. timing of the activities; the 'what', with the techniques selected, and the 'how' i.e. the ethics, the script and the collection of data.

7.3.4 Chi-Co-S Framework

The framework is the output of this research process as a reference for practitioners when considering the implication of each variable involved in the co-design session. To do so, it is structured in *Why-Who-Where-When-What-How* dimensions and provides indications of pro and cons for each element included in them. As it is devised as a tool for reflection in the process of planning the sessions and facilitates the understanding of the implications of each aspect in the output of the session, it is particularly directed to less experienced practitioners. This notation is based on the assumption that so-called expert practitioners have already developed competence and skills through which they can reach a tacit understanding of the given situation and establish strategies for actions without relying on established guidelines (Dreyfus, 1982, as discussed in Chapter 1, Section 1.3). The Chi-Co-S framework does not provide guidelines to follow automatically but rather provides a support for better understanding the effects the elements of the co-design session have on its output and therefore support the planning. In this respect is not limited to novice practitioners but can be used by experts before validating their plans.

Amongst the few other frameworks created for the co-design practice with children, the most related to the Chi-Co-S framework are from Good and Robertson (2006)

and Sluis-Thiescheffer et al. (2011). The CARSS framework developed by Good and Robertson (2006) aims to capture the process of involving children and other relevant stakeholders for designing learning environments, and emphasises the distinction of clear roles of the participants, both children and teachers, and the value they can contribute to the design. With their framework for comparing early design methods for young children, Sluis-Thiescheffer et al. (2011) address the selection of appropriate techniques according to children's diverse intelligences and at the same time on how the outputs of different design techniques can be evaluated and used for design purposes. Both frameworks share with the Chi-Co-S framework the intention to support the selection of resources to employ in the co-design session with children, but while they concentrate the attention on specific aspects (i.e. participants' role in educational contexts in the first, and contributions and selection of techniques and design outputs in the second), the Chi-Co-S framework looks at the co-design session as a whole and how to support the decisions on different aspects that affect its outcome.

7.4 Limitations

As with any piece of work, this research has limitations. The first limitation is in the review of relevant literature. Acknowledging the impossibility of including all the possible literature existing in the field of co-design practice with children, I aimed to include a representative variety of the different points of view on the related research that was useful to contextualise and understand the thesis.

The framework that resulted from the research in this thesis is only one of the many possible outcomes that could have been derived. Research of a reflective and qualitative nature like this is liable to have many different approaches and interpretations; therefore each decision has been underpinned with research evidence and theoretical reference to back its validity.

It can be argued that the framework was derived from a narrow perspective on co-design, namely by co-design sessions in schools with large groups of children who acted as informants and a relatively smaller number of facilitators. As reported in Chapter 2 (section 2.2.2), studies with schoolchildren are the most widely used in co-design research with children and the design studies reported throughout the thesis were mainly set in schools and with the whole classroom of children. However, the

elements included in the framework are not limited to the school context. The nature of the co-design practice and the endless variety of design situations and approaches makes it neither feasible nor sensible to create an exhaustive checklist for supporting novice practitioners in all instances of co-design sessions with children. Therefore, the aim of this framework is to underline important factors to consider in a co-design session without limiting or prescribing specific conditions for the design but allowing for personalisation and adaptation to different design situations.

Finally, many of the considerations and findings related to children are valid also for adult users involved in co-design sessions. This observation is true since many of the practical suggestions included in the framework can be applicable to any co-design practice. However, there are many aspects that relate to developmental factors (i.e. cognitive, social, emotional) that are specific only to children.

7.5 Future Directions

The framework's limitations can also be seen as possibilities for future investigation. Further evaluation is needed to test the applicability of the framework to situations of co-design sessions in more specific contexts like, for example, in a university lab or in children's homes.

The framework is a reflective reference for considering the different aspects involved in the co-design sessions. In this way it is thought of as a dynamic and flexible tool that can be adapted by researchers to suit different design situations. The use of this tool in the Interaction Design and Children research community would provide an additional validation of the effectiveness of the theoretical framework and its continuous improvement. An additional evaluation is in progress at the moment in the form of a survey to get initial feedback on the current tool as it stands. The framework is being sent to expert and novice practitioners on co-design with children to collect their views on the exhaustiveness of the actual version of the framework in covering the most important issues implied in co-design session and its perceived usefulness for novice practitioners.

Since the focus of this thesis was on design research rather than product development (Ellis and Levy, 2008), future work can use the concepts defined through the research of this thesis and develop a functional tool that researchers can interact with.

It can take the form of cards (e.g. Hornecker, 2010; Bekker and Antle, 2011), or web applications (Bevan, 2009). In this instance, the effectiveness of the tool will depend on how the contents of the framework have been implemented to facilitate the user's interaction.

8 Appendices

Appendix 1 – List of Lessons Learnt

From Literature Review:

LR1 – UCD and ID processes are not a unique and prescriptive set of steps. The principles they all share are: the importance of considering users' needs; the iteration of analysis, design and evaluation stages; and the involvement of users in the process

LR2 – Co-design is a useful practice to get users' real insights and design more user-centred product but relies on designers ability to conduct the studies and analyse the results

LR3 – Developmental stages are not the only critical factors to take into account when designing for and with children. Although age is the most straightforward way to distinguish user groups, there are other variables (e.g. social context, community of practice) that influence children's capability to interact with technology and to participate in co-design sessions

LR4 – Most researchers advocate a balance between activities with children and reflections and analysis of designers in the overall design process – as in informant design

LR5 – There is a huge range of techniques applied in design projects. These techniques come from established methods and are adjusted, adapted and modified in each design instance

LR6 – There are a variety of roles and competencies for the different participants in co-design sessions with children that have to be clearly defined

From BEAM project:

B1 – Inclusive approach (i.e. whole classroom) implied adjusting strategies (i.e. quantity vs. detailed information) to available resources (i.e. few facilitators per large number of children)

B2 – The way date were generated (i.e. within groups, prompts used) affected the way they have to be analysed

B3 – Working in groups triggered ideas but also repeated information

B4 – Clear distinction of before, during, after moments helped to identify resources and requirements for the whole process;

B5 – Closing the activity with a presentation (group or individual) gave researchers an understanding of the outcomes and children a sense of completion

From COOL project:

C1 – Using a variety of communication channels allowed children of different intelligences/abilities to express themselves

C2 – Having an open mind towards the outcomes of the design sessions allowed the researchers to embrace novel and unexpected results potentially different from the ones initially sought for

C3 – Benefits for the children (e.g. entertainment, educational, personal) were positive extras that contributed to increase the participants' engagement

C4 – The multidisciplinarity of the teams meant having different approaches to the design sessions, thus demanding a more thorough preparation and explicitness of aims and focus

C5 – Cultural and social backgrounds of participants affected the suitability of the design activities more than age

C6 – The unpredictability of the sessions and participants conditions required to having activities with different formats to adapt to the changing situations

From UMSIC project:

U1 – Facilitators' management of the session and children's engagement identified as the two factors that affect the experience of the sessions and their outcomes

U2 – Outcomes analysed according to their contribution to the context and the content of the design

U3 – Facilitator roles (researchers and teacher) were clearly defined at the beginning to limit biases on children's ideas

U4 – Recording children's explanations during their progress was useful for a clearer understanding and interpretation of the session's output

U5 – Using prompts with different formats (i.e. video, music) helped the engagement of the children in the activities

U6 – Having variation of an activity (i.e. same goal but different ways to achieve it) increased the opportunities to achieve the design aim

Appendix 2 – Design Planning Document

V. 5.1 - July 2010

DESIGN SESSIONS WITH CHILDREN

Introduction

This document intends to serve as a 'road-map' to assist researchers to plan and undertake design studies involving children in the design process. It is intended primarily for researchers who are novice in this practice.

The 'road-map' aims to provide support in understanding the design focus for the study and relevant criteria to follow when planning and selecting methods.

What **to expect** from it: a practical support when planning the study. It includes:

1. brief descriptions of the different stages of the process and of the different factors and variables to consider when making specific design choices would help clarifying objectives and expectations;
2. suggestion of design techniques to get inspiration from;
3. action boxes along the way to encourage reflection during decision-making and assist the creation of the session plan.

What **not to expect**: a ready-made recipe. Each study is unique and there are many possible ways to approach it.

ACTION – What is the context of your design? (try to briefly describe your initial idea of the context in terms of technology, situation, purpose, child users, mode of interaction, etc…) I am intending to design……

IDENTIFY YOUR DESIGN POSITION

When we talk about designing a product we can refer to three different levels of design (Marti & Rizzo 2003):

emergent: envisioning of novel applications that could support emerging human activities
proactive: development of new systems to support current activities
reactive: redesign to settle problems on existing systems

ACTION – So you first have to see whether you are designing to **envision** new design possibilities**, support** a well-known activity and solve an existing problem, or **improving** an existing product (re-design).

What is your position? ……..

For each of these levels, there is a different trade-off of the three main components of design - activity analysis, concept generation, evaluation:

context/activity analysis: investigation of the activity and the context it is to design for,
generation: creation of concepts to implement in the artefact, and
evaluation: test these concepts and their suitability for the context and the initial goal.

The techniques and methods to apply in these different moments of the design process depend mainly on the design objectives and the design situation (design levels). Table 1 below gives an idea of the focus for each stage and of the emphasis of the design component for each level (indicated with the different amount of +, for example, in an emergent design, more emphasis is on the reflection on human activities and the generation of concepts while the evaluation, although fundamental, will be directed to assess abstract concepts).

Table 1 – the egg model (Marti & Rizzo 2003)

	Emergent	Proactive	Reactive
Activity analysis	Reflective exploration ++	Ethnographic studies ++	Task analysis +
Concept generation	Divergent/abstract ideas ++	Convergent/concrete ideas ++	Re-design/improvements +
Evaluation	High level ideas testing +	Concrete ideas testing ++	Usability testing ++

To adapt the egg model of (Marti & Rizzo 2003) to a design where children are involved we introduce children intervention in the same combination of levels and components. Following the Bluebells approach (Kelly et al. 2006), we consider the design process as an **alternation of children and designers collaboration** (children as informants (Scaife et al. 1997) rather than equal design partners (Druin et al. 1998))

The most common controversy towards children involvement in design is how to consider children's contributions in the design of a product, whether their outputs can be considered ready-to-implement design inputs. Our position in the debate is that children's contributions are invaluable inputs, but they are not refined design ideas. As it may occur with adult participants, **users are not designers** so their contribution and insight need to be filtered through design principles that are necessary to achieve 'suitable' design. In the same way, design principles alone are not sufficient to achieve satisfactory and effective products.

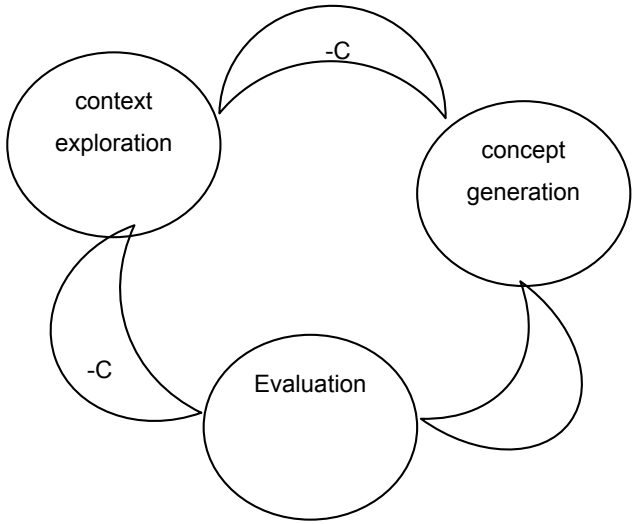


Figure 1. alternation of design stages : directly involving children (+C) and designers only (-C)

For this reason we consider the design process as a **combination** of design phases that alternate direct participation of users (with children: +c) with designers only analysis and design (without children: -c). Each phase will be alternated in an iterative cycle where users insights are filtered by designer's analysis and designers' interpretations and translation will be validated by users' approval (see figure 1).

Table 2 below summarise the alternation of the phases throughout the three main components of the design process that we have renamed: exploration, generation, evaluation, while the three levels of the design are defined as: envisioning, supporting and improving.

ACTION – After having chosen the column where your design session fits, you can then determine where your focus is – is it exploration (opening up the design space), generation (of ideas and methods) or evaluation (of ideas and suggestions)

NOTE HERE that it is sometimes possible in one design session to include all three of these foci with a single group of children but each may need the deployment of different methods.

Table 2 – descriptive table – Egg model adapted to design with children

		ENVISIONING	SUPPORTING	IMPROVING
Exploration	(+c)	++ context analysis here is more abstract as it cannot refer to an existing problem or situation to solve or defined requirements to satisfy. It can take inspiration from similar contexts to reflect on potential and envision future scenarios. In this case children imagination and insight can be very beneficial, achieved for example through fantasy stories.	++ to explore and investigate the context of use, the practice that this activity normally involves, the characteristics of the people who are doing it, the tools they normally use, the spaces, their objectives, their needs. You may use different ethnography inspired techniques, observation, interviews, survey, cultural probes. You can involve the actual users in participating in these activities and get their first hand insights.	+ mainly task analysis, since all the other components are meant to be known
	(-c)	Inspiration for requirements and definition of design focus	Analysis – requirements listing	Analysis - areas for improvements
Generation	(+c)	++ high level/inspirational concepts that are likely to boost creative and innovative ideas	++ initiate the creative process, fed with inputs from the understanding of the context and its needs. The creative process can start by being abstract and divergent leading towards satisfying the requirements emerged in the context analysis. In this phase, children can be involved in the first production of inspiring and divergent ideas, their intervention helps approaching the users' way of thinking and perceiving the problem. To use the emergent ideas into the product design, it is essential children's assistance for a correct interpretation of their outputs and expert analysis for integrating them into feasible design.	+ will go in the direction of concrete improvements of the actual product.
	(-c)	Inspiration for design ideas and context	Integrating in a prototype (low tech)	Implementing the re-design (working prototype)
Eval	(+c)	+ The evaluation in this case would be	++ An iterative evaluative process will filter and refine the evolving	+++ mainly user testing (together

		minimal and related to high level testing of ideas	ideas into more concrete prototypes. Evaluation requires again both usability and design experts' endorsement and children's acceptance.	with usability expert evaluation).
	(-c)	Feasible design concept	Integrate ideas with design requirements	Usability expert evaluation of the new design

DEFINE YOUR DESIGN OBJECTIVES

Once you have identified your design focus in one or more of the design components you can define different sub-goals to achieve with your different design sessions/activities (it'll be hard to satisfy the main project goal within one only session).
You can specify the **design questions** you need an answer for and see how you can match them within the framework, whether they concern exploration of the context, generation of concepts or evaluation of ideas - you can also combine different design objectives within one session, from exploratory to generative to evaluative. You can focus on different aspects of the product you have to design for from **abstract** and contextual information, like attitudes, perceptions or simple inspirations (more common of the envisioning design level), to more **concrete** and specific information, like content, terminology, navigation or interaction modalities (more common, but not only, towards the improving design level).
Apart from adjusting your **expectations** for the sessions, defining your objectives clearly will help you filtering your outcomes during the **analysis**.

This process will help you refine your design objectives and plan suitable activities to achieve them.

ACTION – try to write the specific design objectives for each design activity:

My design objectives are ……..… …
My design questions to be answered from the session are ……

Having your specific design objective/s for the design session you can start planning your session and choose the most suitable techniques to achieve it/them.

PLAN

Once you have clear the design context and the design goal, you can then go on planning a design session: you will have to define your design activities by choosing the appropriate design technique depending on different factors. These factors mainly refer to the flexibility and constraints you have with regards to:

resources you have available (time, tools, spaces, technology),
the **participants** you can involve (adults with different expertise, children with different abilities, stakeholders with different interests)
and **commitments/constraints** (whether you have fixed content to fit in, or specific technology to employ, pre-determined targets to meet).

ACTION – describe your starting conditions….

My resources are ……
My participants are ……
My constraints are ……

Depending on each specific project, these variables will be either fixed or negotiable, that means you will either start from them as conditions/constraints and adjust your design sessions around them to achieve your design goals or, if you have more freedom of choice, you can define them according to your design goal.
In any case you will need to pilot your activities to check on the validity of the plan: are the selected variables appropriate to achieve the expected outcomes with the specific design activity?
To help the planning we identify relevant factors to consider according to the 5 main questions: Who? Where? When? What? How?

WHO?

Participants

You may either adapt your activities to the participants/users skills or look for some participants with the specific skills that will suit your design activity (and/or your design goal). You can consider different categories of skills/intelligence (Chiasson n.d.), (Sluis-Thiescheffer et al. 2007), which may or may not depend only on the **developmental age**, but as well depend on **social practice** or **culture**.
Cognitive / Social / Literacy skills
Logic / Social/ Intrapersonal/ Emotional/ interpersonal/ Physical/bodily kinaesthetic intelligences (Gardner 1993)

Facilitators

They can have different expertise, mainly according to the object of the design. Facilitators should have the same approach on the activities, **sharing the same understanding** of their role, of the activity goal (and of the expected output). They would possibly not influence children's idea, providing prompts rather than solutions to problems.
Having one facilitator after small group of children would make it easier to follow the exact progress of the session and provide assistance every time is needed. Having also some pedagogical or psycho-educational expertise would make the session with children easier to manage. If there is no such expertise in the group of facilitators, they may need the support of the teacher to manage the class and the communication with children.

Grouping

Having group or individual activities may influence the performance and the output. If **individual** activities may allow original ideas, some children may find it difficult to start or to focus. **Small group** can be easier to follow and facilitate but there need to consider social dynamics. **Leading** behaviours may inhibit more introvert personalities and limit the variety of the output. On the other hand, it can facilitate discussion and chain of ideas. **Copying** or imitation is also a frequent behaviour within a group: it is not necessary a negative one but needs to be normalised when analysing the results.
Ideally you can decide your grouping strategy according to the method you decided to use, but sometimes you cannot have flexibility on that decision and need to adapt to external factors (i.e. you are running a session at school and you need to take the whole class for one hour, or on the contrary, you are only allowed to take one children or a small group of children out of the class at a time), in which case you will have to adapt the activity on the given situation.

WHERE?

Space

It refers to either field studies or controlled experiments, which normally means going into schools or bringing the children in a university lab.
If it is a **controlled environment**, depending on how it is set, the children can be distracted by new and interesting things they see around but can also feel more focussed as in a monitored setting and ideally no external distraction may infer.
If it is a **familiar context** for the children, they can feel more at ease and in control, which on one hand may let them focus on the task, but on the other they may wander off to their usual activities if they struggle to keep the focus. Distraction can also come from external factors or actors that do not belong to the activity and are not in control of the researcher (bell ringing, school announcements, etc.)
Another variable of the setting is the **children distribution**. It can be also that all children are in the same room, where they can be doing simultaneously all the same activity or different activities, individually or in small groups. They can also be in different rooms in small groups, or one child at a time doing one activity in a dedicated space.

WHEN?

Timing

Planning the timing is also important. If you are running a session involving more than one activity you need to **coordinate** the shift in order to allow enough time for the children to complete and swap over. They may also need a **break** to keep their attention level at a suitable standard. Too much time is as problematic as too little, as if children finish ahead of time they may get bored or 'wild' if they do not have anything to do → plan **extra small activities** to fill in gaps or unexpected occurrences.

WHAT?

Techniques

All the above variables will affect in one way or another the selection of your methods, where you have to chose the trade-off between your resources and your goal. Try to ensure always **multiple channels** are provided for children to communicate and express their ideas (verbal, visual, physical, textual, etc.)

Plan for unexpected situations. Always have one or two back-up activities in case you cannot run your initial activity.

Below is a list of different types of techniques available, each with its main gal and possible variations, requirements, advantages and disadvantages.

This list does not want to be exhaustive – it possibly cannot – but does aim to cover most of the different range of techniques from which the design activities can take inspiration.

The following tables provide a synthesis of the possible techniques for the different design components and stages (table 3) and details on some of the most common techniques (table 4) – the '-c' lines are greyed out as they refer to the designer's work after the session with children.

ACTION – start building an idea of a set of possible methods for your particular design focus (from the suggested ones or others of your choice – see table 4 later for details on different techniques)

Table 3 - methods suggestion for each design component

		ENVISIONING	SUPPORTING	IMPROVING
Exploration	(+c)	++ Imaginative context - Exploration of context and potential: diaries, ethnographic studies, probes	++ Context analysis - Investigation of the context of use and practice: Contextual inquiry, ethnographic studies,	+ Task analysis - Testing use practice in context: mainly task analysis

			questionnaires, interviews, diaries, cultural probes, technology immersion	
	(-c)	Design focus identification - Inspiration for requirements and definition of design focus	Design requirements - Analysis: requirements listing	Identification of flaws - Analysis: areas for improvements
Generation	(+c)	++ Divergent, innovative solutions to novel situations - Fantasy concepts: future workshops, divergent ideas,	++ Convergent, innovative solution to existing situations – Generating convergent concepts: Brainstorm, Storyboard, Prototype / scenarios, Sketch / drawing / prototype, Role play / presentation	+ Re-design of specific aspects: prototype, sketching, drawing
	(-c)	Inspiration for design idea and context - Take on from children's ideas or insights to evolve a design concept	Visualising - prototyping Integrating in a prototype (low tech)	Implementation - Implementing the re-design (working prototype)
Evaluation	(+c)	+ High level / ideas testing - Test the potential of high level abstract ideas: Low-tech prototype, role-play	++ Prototype testing (iterative) - Selecting the ideas: Low-tech Testing, Interviews, Focus groups, Role play, Drawing, Diaries	+++ Usability test - Testing the re-design: user testing
	(-c)	Design concept feasibility – Discuss and refine the design concept	Integration in the design - Integrate ideas with design requirements	Expert evaluation – Usability expert evaluation of the new design, heuristics

Table 4 – list of types of techniques

Method	Description - Aim	Suggested application	Examples	Requirements	Pro	Cons
Contextual inquiry	Gather children's perception of the context	Exploration	Children observe, take notes, (Druin 1999), interact in the context	-	Experience of context of use from children perspective	Needs time and valid information for interpretation
Ethnographic studies	Understanding of the context of use	Exploration	Field observation, participatory observation	-	Experience of real context of use	Time consuming to organise and to analyse; Access

Questionnaires	Gathering specific and measurable information.	Exploration; Evaluation	Multiple choice, open questions, likert scale, fun toolkit (Read & MacFarlane 2006)	Linguistic	Allow large amount of data in little time; measurable	Children may misinterpret questions Need children's literacy skills
Interviews	Gathering children's individual opinions/ideas on topics	Exploration; Evaluation	(ETR Associates n.d.)	Linguistic, interpersonal	Explore details No need of children's literacy skills	Time consuming Needs interviewer skills to avoid biased answers
Focus group	Gathering children's collective opinions/ideas on specific topic	Exploration; Generation; Evaluation	Group discussion, guided discussion	Linguistic, interpersonal, social	Allow detailed exploration in little time Comfortable for children	Beware of group dynamics and leader effect
Diaries	Children's report on daily activities in context	Exploration	Written, visual (drawing, photos)	Linguistic, intrapersonal	Gather in depth information in the context in the long term Relatively easy for children to complete	Time consuming analysis
Cultural probes	Provoke inspirational response by handing to the children a home pack	Exploration; Evaluation	(Gaver et al. 1999), playful probes (Bernhaupt et al. 2007), photographs	Visual/spatial, linguistic	Gives profound insights in daily life and children's perceptions	Can be time consuming for producing and analysing Mainly inspirational, needs interpretation
Technology immersion	Observe children using technology freely in a specific period of time	Exploration; Evaluation	(Druin 1999),	-	Provides idea on how children use technology in a short period of time	Availability of technology
Brainstorm	Thought shower of ideas with more or less constraints	Generation	Talked, written, drawn	Linguistic, interpersonal	Provide good amount of information over a short period, Quick way to generate ideas	Need contextualisation
Bodystorming	generate ideas by performing	Generation	(Oulasvirta et al. 2003)	bodily kinaesthetic	No need of literacy skills, engaging, inspirational, context related	Abstract results
Future workshops	Envisioning future technology with no reality constraints	Generation	(Kensing & Madsen 1992)	-	Good for divergent phase of ideas generation	Less concrete results
Card-sorting	Organise categories	Exploration; Generation; Evaluation	Visual card sorting (Joly et al. 2009)	Logic	Insight of children perception of the world	Requires thorough analysis

Drawing	Visualisation of ideas and context	Generation; Evaluation	Free drawing, Drawing intervention for evaluation (Xu et al. 2009)	Spatial/visual	Familiar to the children Easy way to communicate ideas, Keep some level of fantasy and imagination/abstractness	Need detailed explanation from children to avoid mis-interpretation
Sketching	Detailed drawing of a concept with description	Generation	Drawing and text, labels	Spatial/visual; linguistic	more informative than simple drawings	Need some abstract thinking from children
Scenarios	Stories describing use cases, including events, settings, actors, tools	Generation; Evaluation	Written (Carroll 2000) / 3d (e.g. plasticine (Mazzone et al. 2008))/ drawn	Logic; linguistic; bodily kinaesthetic (3d); spatial/visual (drawn);	Structured and contextualised information	Needs narrative and linguistic skills
Storyboard	Visual representation of a scenario	Generation	Drawn, 3d	Logic; bodily kinaesthetic (3d s.); spatial/visual (drawn s.);	Visualise use in context	Needs visual and sequential construction skills
Role-play	Evaluate a concept by acting out use	Generation	Perform a scenario	bodily kinestetic; interpersonal	Engaging, encourages natural behaviour, shows ideas in context of use	Interpretation of resulting ideas
Prototype	Represent and evaluate an idea	Exploration; Generation; Evaluation	3d; drawn	bodily kinestetic; spatial/visual; interpersonal	Engaging Allow role play Allow thinking of practical constraints	Depends on material available and manual skills Time consuming in doing and analysing
Presentation	Present an idea, with or without props	Exploration; Evaluation	To peers, to fantasy characters (e.g. Mission from mars (Dindler et al. 2005))	Linguistic; interpersonal	Provide useful information on children's interpretation	May be conditioned by social factors

HOW?

Ethics

Always ensure the activities won't affect children **safety** and **privacy**. Plan so that children are never left alone in the room with one adult or go round alone in unfamiliar places (i.e. university spaces). Make sure they are not put in the position to access inappropriate material (i.e. on the web) or give away sensitive and private information. When in doubt, check with the teacher or the ethic committee/advisor.
Also, make sure the children feel at ease during the activities, that they don't feel forced to do it as they have with normal classroom activities and they are **free to drop out** any time without consequences.

Instructions - Triggers

According to the objective of the activity and/or the phase of the design, the activity can be more or less abstract or concrete. However, instructions need to be quite **simple** and **specific**. It is helpful to provide **concrete references** that are familiar to children's world, where they can refer to in order to understand what is it that they have to be doing and what it is expected from them. Having visual clues or triggers may facilitate the setting off (i.e. trigger video as in (Briggs & Olivier 2008), adapted to children as in Mazzone et al. 2010)) and could be used as a reminder during the activity if they are falling off topic.

Make sure the activity and the way it is presented to the children is **suitable** for children's age, cognitive development or cultural background. Check with an expert or a teacher if in doubt.

Feedback – Data collection

Record the activities and their outcomes both **during** and at the **end**. It can be done through video, researchers notes, children's final presentation. Triangulation of data collection methods/sources of data is needed to improve validity of results and confidence in analysis. Collected materials need thorough explanation in the moment, otherwise the afterwards interpretation can be difficult and imprecise. Ideally, you can have analysis session with children, either as individual interviews or as focus group, where you ask them to explain their outputs and critically analyse them (evaluate ideas).

Be aware that In most of the cases time doesn't allow for this thorough process, so the researchers will analyse the data on their own according to the design focus of the activities (i.e. elicit requirements, select design ideas, implement a prototype, etc. - see all the '-c' in table 3). The output of the analysis will then feed the following phase of the design and be tested with children (design for the requirements, test the selected ideas, etc.).

Be **realistic** on what to expect from children – more than refined design ideas it is likely that you will get insight and original hints that will trigger the development of more feasible design ideas from the designers.

ACTION –

My selected methods for each design focus are ……..…… ……...….
My 5 WH/HW are……..
My back up plan is……...……
I will collect the following data……...……
The ethical concerns are……...……..

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Appendix 3 – Researcher's Pre-session Questionnaire

Pre-session questionnaire

What is your definition of:

design?

design session?

What is your expertise in:

design?

design sessions with children?

How many design session with children have you participated in so far?

What was your role in those?

What is the design goal of the study you are participating in next?

What would be your role?

What are your expectations from the design session with children?

Appendix 4 – Research Study: Instructions

About the Research Study

Tool

The tool is a 'road-map' that aims to help researchers who are novice in planning and undertaking design studies involving children. It intends to ease the understanding of the design focus for the study and relevant variables and criteria to take into account when planning and selecting activities for the design sessions.

Design of the study

We plan a set of three different design studies to test the usefulness and ease of use (effectiveness) of this tool.
Each study refers to a different level of design, as defined in the tool. One study regards the re-design of an existing product/technology, the second is to design a novel technology for a well-defined context, the third is to design a novel technology for a novel context.
Evaluation is made through research diaries, post session interview.

Participants

One leader researcher for each study helped by few assistant researchers.
Leader researchers have different levels of design expertise and little experience of designing with children.
In each session participated a classroom of school children of different school year.

Procedure

A pre-session **questionnaire** is submitted to the researchers in order to define their design expertise and the design goal of the study.
Prior to the design session, each pair of researchers goes through the tool and starts planning the design activity for a specific design goal/s.
During the study, they take note (**research diary**) of the use they make of the tool and of the external aid they need - from discussion with peer or expert designers for advice, to literature for reference of application of specific design techniques.
After the session the **children** fill in a fun toolkit questionnaire about the experience and the **teachers** write their views on the session. An **expert designer** who took part in the study as an assistant researcher is also asked to write their opinion about the session and interviewed if needed.
The researchers are then interviewed about the use of the tool in their design session. In the **interview** the researchers report on the different

stages of the design, the usefulness of the tool, what they found most helpful, what they found least useful, what they found unclear, what they struggled the most in the whole study and what improvements they would suggest for the tool.
The information collected throughout the study is analysed in a qualitative way in order to identify effectiveness, usefulness and satisfaction of the use of the tool. The analysis will inform improvements for the tool.

Appendix 5 – Research Study: Diary

During the study, please take notes on:

the use I made of the tool
how easy it was to understand and follow (easiest bit / hardest bit)
the external aids I sought for (from discussion with peers and/or expert designers to seek for advice, to literature to find references of application of specific design techniques, and so on)
the parts of the tool I followed
the parts I did not follow
the parts I made different

Appendix 6 – Children's Questionnaire

BOY ___ GIRL ____ AGE _____

How much FUN was the design activity?

☺ What PART of the activity did you like the BEST?

Why?

☹ What PART of the activity did you like the WORST?

Why?

Appendix 7 – Teachers' Notes

TEACHER'S NOTES **Date _____** **SCHOOL YEAR ____**

What has been VERY GOOD about the design session?

What has been NOT SO GOOD about the design session?

Appendix 8 – Expert Designers' Notes

EXPERT DESIGNER'S NOTES **Date _____** **SCHOOL YEAR ____**

What has worked VERY WELL in the design session?

What has worked NOT SO WELL in the design session?

Appendix 9 – Framework v0.1

DESIGN SCOPE AND OBJECTIVES

what is the scope of the design project?

- improving existing product
- supporting existing activities in a novel way
- envisioning novel product/activity

what is the focus of the session within the selected scope?

- exploring the context of use
- generating abstract/concrete ideas
- evaluating concepts

			PROJECT SCOPE		
			Envisioning	Supporting	Improving
SESSION'S OBJECTIVES	Exploration	with children	As it does not refer to an existing problem or situation to solve or defined requirements to satisfy, it can take inspiration from similar contexts to reflect on potential and envision future scenarios. In this case children imagination and insight can be very beneficial, achieved for example through fantasy stories.	To explore and investigate the context of use, the activities that are usually involved, the characteristics of the people who are doing them, the tools they normally use, the spaces, their objectives, their needs. Actual users can participate in these activities and provide their first hand insights.	Mainly task analysis, since all the other components are meant to be known
		without children	Inspiration for requirements and definition of design focus	Analysis – requirements listing	Analysis - areas for improvements
	Generation	with children	High level/inspirational concepts that are likely to boost creative and innovative ideas	The creative process can start by being abstract and divergent leading towards satisfying the requirements emerged in the context analysis. In this phase, children can produce inspiring and divergent ideas, their intervention helps approaching the users' way of thinking and perceiving the problem. To use the emergent ideas into the product design, it is essential children's assistance for a correct interpretation of their outputs and expert analysis for integrating them into feasible design.	Concrete improvements of the actual product.
		without children	Inspiration for design ideas and context	Traducing abstract ideas and insights and design requirements into a prototype (low tech)	Implementing the re-design (working prototype)
	Evaluation	with children	The evaluation in this case would be minimal and related to high level testing of ideas	An iterative evaluative process will filter and refine the evolving ideas into more concrete prototypes. Evaluation requires both usability and design experts' endorsement and children's acceptance.	Mainly user testing (together with usability expert evaluation).
		without children	Feasible design concept	Integrate ideas with design requirements	Usability expert evaluation of the new design

DEFINING VARIABLES

What are the **CONSTRAINTS** for the session?
Consider the availability of:

/Time:
/space:
/participants:
/facilitators:
/content:
/technology:
/others:

Given the DESIGN SCOPE, the SESSION'S FOCUS and the initial CONSTRAINTS identified above, define the variables to manage the session.

The following WH/HW sections (in no particular order) provide an overview of the implications of different options that can support each decision

In each decision, the suitability for the different skills of children
/ Cognitive
/ Social (Intrapersonal)
/ Emotional (Interpersonal)
/ Physical/bodily
/ Literacy
/ Logic
need to be accounted to guarantee **CHILDREN'S** successful **ENGAGEMENT**

WHO

my participants' roles are:

- children: evaluators/creators/ others
- facilitators: observers/helpers/participants/others
- experts: consultants/observers/participants
- others: _____

children and facilitators will be distributed:

- children: individually/pairs/groups of *n* children
- facilitators: assigned to groups/rotate

WHERE

The session will be held at:
The space will be arranged as:
Possible distractions will be

WHEN

The session will be organized as:

– duration of session
– duration of single task/activity

– breaks and transitions
– back up tasks

WHAT

(see table of techniques below)

I will do the following activities:
Apply the following techniques:
Use the following props:
Make available the following variants of the activities:

HOW

My ethical concerns are:
The brief will be delivered with … by …
I will make sure the children will be engaged as:
By doing:
I will collect the data as:
The data will be analysed as:
I will feed back to the children and the teachers

TECHNIQUES OVERVIEW (alphabetical order)

Technique	Description - Aim	Suggested application	Examples	Required skills	Pro	Cons
Bodystorming	generate ideas by performing	Generation	(Oulasvirta et al. 2003)	bodily kinaesthetic	No need of literacy skills, engaging, inspirational, context related	Abstract results
Brainstorm	Thought shower of ideas with more or less constraints	Generation	Talked, written, drawn	Linguistic, interpersonal	Provide good amount of information over a short period, Quick way to generate ideas	Need contextualisation
Card-sorting	Organise categories	Exploration; Generation; Evaluation	Visual card sorting (Joly et al. 2009)	Logic	Insight of children perception of the world	Requires thorough analysis
Contextual inquiry	Gather children's perception of the context	Exploration	Children observe, take notes, (Druin 1999), interact in the context	–	Experience of context of use from children perspective	Needs time and valid information for interpretation
Cultural probes	Provoke inspirational response by handing to the children a home pack	Exploration; Evaluation	(Gaver et al. 1999), playful probes (Bernhaupt et al. 2007), photographs	Visual/spatial, linguistic	Gives profound insights in daily life and children's perceptions	Can be time consuming for producing and analysing Mainly inspirational, needs interpretation
Diaries	Children's report on daily activities in context	Exploration	Written, visual (drawing, photos)	Linguistic, intrapersonal	Gather in depth information in the context in the long term Relatively easy for children to complete	Time consuming analysis
Drawing	Visualisation of ideas and context	Generation; Evaluation	Free drawing (i.e. Pictive (Muller, Drawing intervention for evaluation (Xu et al. 2009)	Spatial/visual	Familiar to the children Easy way to communicate ideas, Keep some level of fantasy and imagination/abstractness	Need detailed explanation from children to avoid mis-interpretation
Ethnographic studies	Understanding of the context of use	Exploration	Field observation, participatory observation	–	Experience of real context of use	Time consuming to organise and to analyse; Access
Focus group	Gathering children's collective opinions/ideas on specific topic	Exploration; Generation; Evaluation	Group discussion, guided discussion	Linguistic, interpersonal, social	Allow detailed exploration in little time Comfortable for children	Beware of group dynamics and leader effect
Future workshops	Envisioning future technology with no reality constraints	Generation	(Kensing & Madsen 1992)	-	Good for divergent phase of ideas generation	Less concrete results

Interviews	Gathering children's individual opinions/ideas on topics	Exploration; Evaluation	(ETR Associates 2007)	Linguistic, interpersonal	Explore details No need of children's literacy skills	Time consuming Needs interviewer skills to avoid biased answers
Presentation	Present an idea, with or without props	Exploration; Evaluation	To peers (i.e. Bluebells blind man's bluff (Kelly et al. 2006); collective presentation); to fantasy characters (e.g. Mission from mars (Dindler et al. 2005));	Linguistic; interpersonal	Provide useful information on children's interpretation	May be conditioned by social factors
Prototype	Represent and explore ideas and concepts	Exploration; Generation	3d; drawn	bodily kinestetic; spatial/visual; interpersonal	Engaging Allow role play Allow thinking of practical constraints	Depends on material available and manual skills Time consuming in doing and analysing
Questionnaires	Gathering specific and measurable information.	Exploration; Evaluation	Multiple choice, open questions, likert scale, fun toolkit (Read & MacFarlane 2006)	Linguistic	Allow large amount of data in little time; measurable	Children may misinterpret questions Need children's literacy skills
Role-play	Evaluate a concept by acting out use	Generation	Perform a scenario	bodily kinestetic; interpersonal	Engaging, encourages natural behaviour, shows ideas in context of use	Interpretation of resulting ideas
Scenarios	Stories describing use cases, including events, settings, actors, tools	Generation; Evaluation	Written (Carroll 2000); 3d (e.g. plasticine (Mazzone et al. 2008)); drawn	Logic; linguistic; bodily kinaesthetic (3d); spatial/visual (drawn);	Structured and contextualised information	Needs narrative and linguistic skills
Sketching	Detailed drawing of a concept with description	Generation	Drawing and text, labels	Spatial/visual; linguistic	more informative than simple drawings	Need some abstract thinking from children
Storyboard	Visual representation of a scenario	Generation	Drawn, 3d	Logic; bodily kinaesthetic (3d s.); spatial/visual (drawn s.);	Visualise use in context	Needs visual and sequential construction skills
Technology immersion	Observe children using technology freely in a specific period of time	Exploration; Evaluation	(Druin 1999),	-	Provides idea on how children use technology in a short period of time	Availability of technology

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Appendix 10 – Framework v1.0: The Chi-Co-S (Children Co-design Session) Framework

WHY

The *Why* section helps in identifying the general design scope and defining the objectives for the specific design session. Having clear objectives for the session facilitates the selection of resources and techniques to employ in the sessions and set feasible expectations of the outputs.

WHY		Design scope		
		Improving (re-design of existing products)	Supporting (design a new way to support a well-known activity / solve an existing problem)	Envisioning (Envision novel situations of use and future technology)
Session's objective	Context exploration (retrieve information on context of use)	Investigate the use of existing technology	Explore context of use and related activities	Reflect on context and values
	Concept generation (generate concepts or ideas)	Re-design technology	Generate novel solutions for defined requirements	Define possible concept scenarios
	Evaluation (test and validate earlier solutions)	Evaluate improved usability	Evaluate satisfaction of user needs and design requirements	Evaluate high level/abstract concepts

WHO

The *Who* section includes considerations on experts, facilitators and children grouping strategies together with the different implications each decision may have on children's performance.

WHO	Pro	Cons
Experts	**Support the definition of suitable activities**	
- Pedagogues	Advise on suitability of activities for children and feasibility of expected results; Advise on behaviour management and specific children's skills (Teachers can cover this role for schoolchildren)	May clash with design perspective; May have different aims than the session's and bias some decisions

- Domain	Ensure appropriate focus on the subject topic	Risk of digress from design objective
Grouping	**Grouping strategy have impact on the results and needs to be accounted in the outputs' analysis**	
- Individually	Allow original ideas; Easy to follow and collect data	Children may find it difficult to start off or be inhibited by power relations
- Groups	Provoke discussion and chain of ideas; Reduce time and facilitators/child	Leaders may take over more introvert personalities and limit outputs' variety; Copying and imitations may need to be normalised when analysing the results
Facilitators	**Share the same approach on the activities, understanding of their role, of the activity goal (and of the expected output)**	
- Observers	Record what happens during the session; take care of logistics	Risk of observers' effect
- Assistants	Support children in the tasks, providing prompts - not solutions - to problems	Risk of influencing children's ideas and/or their interpretation

WHEN

For the *When* section, options are presented for time management and planning for flexibility.

WHEN	Pro	Cons
Timing	**Manage time resources**	
Duration	Adapted to children's attention span and activities goals	May need to be adapted to external constraints
Breaks	Allows for task shifts and children's rest	Interrupt the flow
Simultaneous (in different or same space)	More activities running at the same time can get more output in less time	Harder to manage; Need more facilitators
Flexibility	**Having back-ups of activities of different duration**	
Variations in duration	Allows for adapting to children's changing need or unexpected events	Can have effect on outputs for analysis and comparison

WHERE

The *Where* section presents possible sources for distractions, together with the space distribution: children can be located in the same room, doing simultaneously all the same activity or different activities, or in a dedicated space for each activity.

WHERE	Pro	Cons
Distractions	**Control possible distractions related to different contexts**	
- Familiar context (i.e. school, home)	Children can feel at ease and in control, facilitating focus on the task	Children can be distracted by routine activities or external interruptions
- Unfamiliar context (i.e. lab)	Children can feel more focussed as in a monitored setting	Children can be uncomfortable or attracted by new and interesting things they see around - if the space is not properly set
Distribution	**Where to allocate the activities**	
- Isolated (one activity per space)	Better control of the activities by the facilitators	Needs more time and/or more facilitators to reach a large number of children
- Joined (more activities in the same space)	Needs less resources	Increases risk of chaos and distractions; Needs more coordination

HOW

The *How* section starts with ethics, and follows with tips on the different ways to brief the activity and ends with a discussion about data collection. This last point is directly related to the analysis of outputs, which is essential to determine the session's success. For example, the afterwards interpretation of children's output is often difficult and uncertain but can be helped with an accurate collection of data and children's explanations in the moment.

HOW	Pro	Cons
Ethics	**Safety, privacy, freedom to drop out**	
Data collection	**Affects the way outputs are understood and interpreted afterwards**	
- Video / audio recording	Provides evidence for afterwards analysis	Time consuming to analyse; Risk of observers' effect
-Artefacts /pictures	Provides evidence for afterwards analysis	Need children's explanation or contextual notes for

		interpretation
- Presentation of ideas	Gives children a sense of completion and researchers information on the outputs	Some children do not like to talk in public
- Progressive	Record the building of ideas and gives insight to children's way of thinking	Time demanding
Instructions	**Brief of the activities to complete**	
- Examples	Concrete references that are familiar to children and they can refer to in order to understand what they are expected to do	Can influence or bias their ideas
- Triggers	Having visual clues or triggers may facilitate the setting off and focus during the activity	Risk of digression from topic
Fun	**Including engaging elements to the activities**	
	Engage children in the activities	Need to be controlled to avoid distraction from topic
Data analysis	**Interpret and analyse session's outputs**	
- Refer to objectives	Focus the analysis of the outcomes	Risk of limit new solutions
- Multi-disciplinarity	Allows interpretation of outcomes from different perspective and not only looking at strictly design implications	Need more coordination and communication
- Iterative process	Allows evaluation and refinement of results	Time consuming

WHAT

The *What* section includes a table with an alphabetic list (not meant to be exhaustive) of the most common techniques used in co-design sessions for children. Each technique has a brief description of its intended aim, some examples of possible variations, identification of the design stage of application, indication of the required children's skills, and a summary of the pros and cons of its employment. The introduction of props and of variants of creative techniques is important to trigger children's ideas and adapt to children's different ways of expressing themselves.

WHAT	Pro	Cons
Techniques	**Please refer to the table below**	
Variants	**Having back-ups of activities employing different modalities**	
- Different communication channels	Allows children to express themselves in the preferred way (text, drawing, talking, making, acting)	Need more time for analysis and comparison of outputs

Props	Use of materials or technology to support the activities	
	Help focus children attention	Can bias the results if not tested beforehand

Examples of techniques to use in co-design sessions

Technique	Description - Aim	Suggested application	Examples	Required skills	Pro	Cons
Bodystorming	Generate ideas by performing	Generation	(Oulasvirta et al., 2003)	Bodily-kinaesthetic	No need of literacy skills; engaging; inspirational; context related	Abstract results
Brainstorming	Thought shower of ideas with more or less constraints	Generation	Talked (Sluis-Thiescheffer et al., 2007), written, drawn	Linguistic, interpersonal	Provide good amount of information over a short period; Quick way to generate ideas	Need contextualisation
Card-sorting	Organise categories for understanding navigation patterns and information architecture	Exploration; Generation; Evaluation	Card sorting (Spencer, 2009), visual card sorting (Joly et al., 2009); InfoTree (Baek and Lee, 2008); tangible: InfoBlock, (Baek and Lee, 2008)	Logic	Insight of children perception of the world	Requires thorough analysis
Contextual inquiry	Gather children's perception of the context	Exploration	Children observe, take notes, (Druin, 1999), interact in the context	–	Experience of context of use from children perspective	Needs time and valid information for interpretation
Cultural probes	Provoke inspirational response by handing to the children a home pack	Exploration; Evaluation	(Gaver et al., 1999), playful probes (Bernhaupt et al., 2007), photographs	Visual/spatial, linguistic	Gives profound insights in daily life and children's perceptions	Can be time consuming for producing and analysing Mainly inspirational, needs interpretation
Diaries	Children's report on daily activities in context	Exploration	Written, visual (drawing, photos), (Berry and Hamilton, 2011)	Linguistic, intrapersonal	Gather in depth information in the context in the long term; Relatively easy for children to complete	Time consuming analysis
Drawing	Visualisation of ideas and context	Generation; Evaluation	Free drawing (i.e. Pictive (Muller, Drawing intervention for evaluation (Xu et al., 2009)	Spatial/visual	Familiar to the children; Easy way to communicate ideas; Keep some level of fantasy and imagination/abstractness	Need detailed explanation from children to avoid mis-interpretation
Focus group	Gathering children's collective opinions/ideas	Exploration; Generation;	Group discussion, guided discussion (Hennessy and	Linguistic, interpersonal,	Allow detailed exploration in little time;	Beware of group dynamics and leader effect

	on specific topic	Evaluation	Heary, 2005)	social	Comfortable for children	
Future workshops	Envisioning future technology with no reality constraints	Generation	(Kensing and Madsen, 1992)	-	Good for divergent phase of ideas generation	Less concrete results
Interviews	Gathering children's individual opinions/ideas on topics	Exploration; Evaluation	(ETR Associates, 2007)	Linguistic, interpersonal	Explore details No need of children's literacy skills	Time consuming Needs interviewer skills to avoid biased answers
Presentation	Present an idea, with or without props	Exploration; Evaluation	To peers (i.e. Bluebells' blind man's bluff (Kelly et al., 2006); collective presentation); to fantasy characters (e.g. Mission from mars (Dindler et al., 2005));	Linguistic; interpersonal	Provide useful information on children's interpretation	May be conditioned by social factors
Prototype	Represent and explore ideas and concepts	Exploration; Generation	3d, drawn, (Muller, 2003)	bodily kinestetic; spatial/visual; interpersonal	Engaging; Allow role play; Allow thinking of practical constraints	Depends on material available and manual skills Time consuming in doing and analysing
Questionnaires	Gathering specific and measurable information.	Exploration; Evaluation	Multiple choice, open questions, likert scale, fun toolkit (Read and MacFarlane, 2006)	Linguistic	Allow large amount of data in little time; measurable	Children may misinterpret questions Need children's literacy skills
Role-play	Evaluate a concept by acting out use	Generation	Perform a scenario (Seland, 2009)	bodily kinestetic; interpersonal	Engaging; encourages natural behaviour; shows ideas in context of use	Interpretation of resulting ideas
Scenarios	Stories describing use cases, including events, settings, actors, tools	Generation; Evaluation	Written (Carroll, 2000); Drawn.	Logic; linguistic; bodily kinaesthetic (3d); spatial/visual (drawn);	Structured and contextualised information	Needs narrative and linguistic skills
Sketching	Detailed drawing of a concept with description	Generation	Drawing and text, labels, (Hemmert et al., 2010)	Spatial/visual; linguistic	more informative than simple drawings	Need some abstract thinking from children
Storyboarding	Visual representation of a scenario	Generation	Comicboarding (Moraveji et al., 2007); 3d (e.g. plasticine (Mazzone et al., 2008b));	Logic; bodily kinaesthetic (3d s.); spatial/visual (drawn s.);	Visualise use in context	Needs visual and sequential construction skills
Technology immersion	Observe children using technology freely over a period of time	Exploration; Evaluation	(Druin, 1999),	-	Provides idea on how children use technology in a short period of time	Availability of technology

9 List of Related Publications by the Author

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