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Experience focused Requirements Gathering with Children and Young People - Balancing Player, Learner and User (PLU) Requirement Needs

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Abstract. This chapter is bridging the gap of Human Computer Interaction (HCI) and Requirement Engineering (RE) where the intended users or appropriators of the technology or service are children and young people. The research draws theory and practices from several disciplines: Human Computer Interaction (HCI) and Interaction Design (IXD) but also from psychology, educational technology and games.
Research into children and young people's requirement needs as Player, Learner and User (PLU) is a main theme in Interaction Design for Children (IDC). This chapter focuses on the challenges and issues that arise when conducting requirement gathering with children and young people; it looks at common methods, approaches and methodological innovation in the current research while treating children as research partners in the requirements gathering process

HCI, Requirement Engineering, Child-Computer Interaction (CCI), Children, User Experience, User-Centred Design (UCD), participatory design

1 Introduction: Child-Computer Interaction (CCI), Children's Experience

CCI or Child-Computer Interaction is a reasonably newly established discipline that focuses on Human-Computer Interaction (HCI) where the intended users or appropriators of the technology or service are children and young people. It grew from pockets of work, mainly driven by interests in technology use within education and schools, in its own early years, before developing into an identifiable community within the HCI space which is beginning a process of maturing into its own discipline with its own associated methods and solutions [1] as an IFIP SIG group[1].

Similar to the multidisciplinary HCI, CCI draws theory and practice from several disciplines, and lessons are learned from the current practices of working with children in various fields. It is often inspired by child-centred participatory approaches that originated from child psychology and social science.

[1] http://www.idc-sig.org/

The book Researching Children's Experience [2] has provided methods and approaches in developmental psychology: from naturalistic observations to participatory research with children and the humanistic participatory way of working with children is common in childhood studies and social sciences. Some examples of influential works in the field are the 'Mosaic Approach'[3] and 'The Hundred Languages of Children' [4]; they work with the nature of children's expressions: diverse, divergent and intertwining. The recent review on methodology of working with children [5], and investigations on various children's social experiences [6] have raised the common point, that there has been a methodological shift, involving the emergence of new 'participatory' research methodologies, the adaptation of more traditional methods, such as observation, and the development of multi-method approaches.

2 Children and Young People's Requirement Needs

User Experience (UX) is the new usability. Technology for children and young people is increasingly becoming experience focused, and in doing so considers their experiences as Players, Learners and Users (PLU). The PLU model [1, 7] defines how children interact with technology and maps how their three distinct requirement needs as Players, Learners or Users; can be met by technologies that are described as Entertainment, Education, and Enabling. The intended relationship of child to the technology assists in considering how the interactive product may be designed and developed:

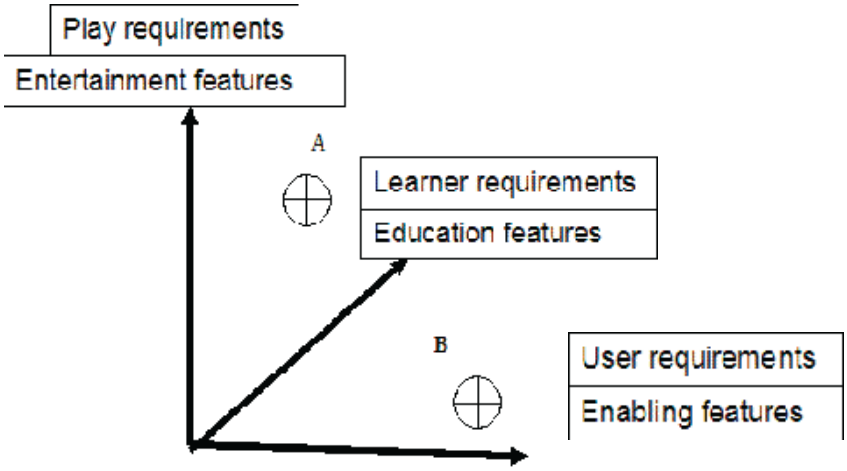


Fig. 1. The PLU Model [1]

- **Player Requirements** - The child sees the interactive product as a toy and gameplay thing; the product must amuse or entertain, be fun and challenging. Example technologies are games and interactive toys.
- **Learner Requirements** - The interactive product is a learning tool similar to school or a teacher; the product is expected to instruct, challenge and reward. Typ-

ical examples are educational software and Virtual Learning Environments (VLEs).

- **User Requirements** - For the product to be useful it must enable the child and make things easier to do. The examples can be handwriting recognition software, a word processor, an energy use tracker or an interactive TV.

The PLU model demonstrates children's different roles and activities from both children's and adults' perspectives; in picking up a product, the children's concern may be all about play, while adults might place the importance on learning. Most children's products share two or three of the (PLU) requirement features, an example is educational games: these have to be playful, appealing to children and at the same time delivering the expected learning benefit; that is to balance the different requirement needs and to meet the interests of all stakeholders.

To carry out requirements gathering with children and young people, an understanding of some of the differences between adults and children and their use of technology can be established [7]:

2.1 Children as Players

Children find play natural, they have high levels of imagination, so much of their play can be hard to visualize for adults. In requirement gathering, if asked, the children might say that they have been playing, but it can sometimes be difficult to observe. Play is essential for children because it contributes to their development (they do not play just to relax). Children learn by playing, but they may not report that they learned something if the learning was a result of the play.

2.2 Children as Learners

Children have more to learn than adults do, so they have to learn more quickly and efficiently. The effort they report when learning might seem lower than would be expected given the difficulty they may demonstrate on their faces, however they learn more easily, and much of what they learn is informal. When asked, children might not even know what they learned. Children are into learning; they find it very natural and have a lot of curiosities. It is highly likely that children will learn things that had not been planned into an activity. It should be noted that children's mental models are often incomplete, so they may not be able to explain why things are the way they are. They might not be able to give reasons for the things they do.

2.3 Children as Users

Children age more quickly, so their needs for technology keep changing; it is essential to ensure that technology is age appropriate. They have different motivations than adults. They only use technology if they want to; they also have much more discretion than adults. If they don't like what is put in front of them, they may walk away.

Children expect more from ordinary products. They may believe that technology is magic, this can lead to high expectations that may not be realized and may discourage the child.

As all the differences suggest, children and young people are NOT simply small adults, their unique requirement needs for interactive products and services should be considered.

3 Establishing Requirements

The activity of understanding what a product should do is variously described as requirements gathering, requirements capture, requirements elicitation, requirements analysis and requirements engineering [8]. The term 'establishing requirements' is often used to describe the process of finding out what users may want or need in a system [9].

Establishing requirements is about understanding the potential users. It provides insight into the many possible solutions in order to select and investigate the best solution from the users' perspective. The requirements gathering phase is the period when the product team must do its initial research in order to determine the direction of the product, which is critical in creating a basis for the design. Poor requirements collection will impact the remaining stages of the product life-cycle, which will end up with misguided products that won't sell, or products that may be unusable and useless to the user and/or the company that purchases them [10].

A requirement is a statement on what a product should do, or how it should behave. Rogers et al [8] have identified five different types of requirement for systems that are being developed for adults:

- Functional requirement - a statement of what the product should be able to do.
- Data requirement - a statement about the data within the product.
- Environmental requirement - specify the circumstances within which the product will operate; this will include the physical environment, the social environment, the organizational environment and the technical environment.
- User requirement - used to capture the characteristics of the user group; their skills, whether they are novices or experts, whether they will be casual or frequent users.
- Usability requirements - will be concerned with effectiveness and efficiency, accessibility and learnability.

Among the five types of requirement, the first three tend to be more system focused, while the User and Usability Requirements are more about the user and the usage of the product in situ. In many cases, determining requirements is best done with the assistance of real or potential users, especially when the potential users are children [9].

4 Requirements Gathering with Children and Young People

End users' expertise in the development of new applications is acknowledged in user-centred participatory design. Similarly, children's experience of what they find enjoyable and how they learn is a valuable source of inspiration for the design of products intended for them [11]. A child-centred interaction design requires methods suitable to gather information from and about children. Though different opinions about what role children should play range from very active design partner [12, 13] to a less active role as informants [14], most people agree that children can provide useful insights into the design and development of their technology and service [15].

There are a number of common methods and approaches for gathering requirements to inform Interaction Design for Children (IDC): from traditional methods like observations, interviews and questionnaires, to recent methodological innovations that have been specifically tailored to children, such as Drawing Intervention (DI) [16] and Obstructed Theatre [17, 18].

In general, with a user-centred participatory approach, there are three means by which requirements can be gathered:

- Observation: watching children on what they do.
- Interview, focus group and survey: asking children about their opinions.
- Participatory Design: doing design with children.

Most of the time, the three approaches of "watch, ask and do" are combined to achieve a triangulation of the data, e.g. combining observed and reported requirement needs. The following subsections explore some of the common methods and approaches and how they could be applied in practice.

4.1 Observations, Watching What Children Do

One simple approach to working with children is by observing what they do in a realistic setting. Generally speaking, the term observation refers to an examination of a phenomenon that results in a description suitable for the purpose of a research study [7]. For example, field observation combined with low-tech probes has been used for requirement gathering for a multimedia museum environment with 5 to 10-year-olds [19]; and classroom observation followed by surveys was used for understand what is needed for a handwriting recognition interface for children aged 6 to 7 (Read, MacFarlane et al. 2004).

Naturalistic observation is often a preferred approach when working with children, as, compared to working in a lab, children in their familiar environment are more relaxed and at ease, with any observer effect minimised. Also by working in children's natural environments, product use is naturally embedded in their everyday activities and the interactions take place within their social setting and context, which can be hard to replicate or capture in a lab.

In a number of observational studies, a probe or a mock-up of the system is used to prompt technology and non-technology related requirements during the observation.

These can be non-functional prototypes made of low-tech materials like paper and cupboards [19] or they could be storyboards that show the basic idea of the technology to be developed [20]. Sometimes the Wizard of Oz technique is used to gather hardware requirements [21] and other times Video prototypes are used to demonstrate how the system, if made, might have worked [22].

Observation can be direct or indirect. Direct observation is done by the observer, who might watch or listen to what children do. Indirect observation can use photos, audio and video recordings. In some research studies, both direct and indirect observations are employed for rich data. A direct observation can be structured or unstructured. In an unstructured observation, open questions may be asked and the record will be rich descriptions of context without a priori limiting of the range of events or behaviours. The advantage of unstructured observation is its open-endedness that welcomes surprises and new discoveries. In practice, though, lack of focus can cause some problems and can lead to a low reliability of results between observers due to subjectivity. The observational data may also be many but irrelevant or contrived and may not serve the goals and difficult to analyse.

As an alternative, a structured observation can be carried out. Compared to an unstructured observation this will be more focused and will directly serve the goal of the requirement study. In [7], the following steps of a structured observation are explained in details:

1. Determine the focus of your observation
2. Develop observation guides and forms
3. Recruit and train observers
4. Carry out the observation
5. Analyse the interpret findings

The focus of the observation is what is being looked for and having a focus means being selective and observing specific events, activities and behaviours. Observers can make more numerous, more detailed, and more reliable observations when they have a specific focus. When developing observation guides and forms, it may be helpful to involve someone with expertise at the particular age of the children, e.g. a teacher, parents and other members of the design team [7].

Encourage Children's Verbalization during the Observation.

While observation takes place, it is common to encourage children's verbalization, as this can reveal more of their experience. The verbalization could be children with their peers in a group brainstorming ideas, with discussion, drawings and investigating existing technologies [23]; or an agent could be introduced for eliciting their self-report.

An example of the innovative use of an agent is the 'Mission from Mars' method used alongside a participatory design session [24] Martians are introduced for a shared narrative space with children, providing a first-hand insight into children's practice in a fun and intriguing way. The method is proposed as a supplement to existing descriptive design methods for interaction design and children. Similarly, 'Designing for Mr

Hippo' [25] explored metaphoric design for marginalised children, to provide a fun and easy way for children to begin to understand how to design for users who are not the same as themselves. In both cases, the agents are introduced to encourage children's verbalisation, and for improved self-report.

4.2 Interview, Focus Group and Survey, Asking Children their Requirement Needs

Asking children about their requirement needs can be a challenging task, as children's logic, linguistic, cognitive, and communication skills are still developing. Especially for shy young children, they have great difficulties to articulate to a stranger (researcher) in an alien environment. In the field of CCI, some child appropriate alternatives of the interview and questionnaire techniques have been specifically developed.

An interview is a guided conversation in which the researcher seeks information from a child. Given that interviews are flexible and can be used as a solo activity or in conjunction with other user requirements activities, it is one of the most frequently used user requirements gathering techniques. The end result of a set of interviews is an integration of perspectives from multiple users for a holistic view of the system being designing for [10]. An interview with a child has to be non-threatening, the child to be interviewed may be selected according to his/her verbal communication skills and personal characteristics; for example, the child may be chosen because he/she is articulate and outgoing, it is less common to interview very young children however interviews can be done among children themselves as in KidReporter [15], as this minimises unfamiliarity and increases the relevance, and the chance of there being asked child-understandable questions.

One alternative to interviews is the focus group, where the researcher works with a group of children in a setting children are familiar with. In a study of designing energy saving devices with teenagers (Bell, Toth et al. 2013), a small number of children were brought together for an hour or so to provide information in response to a series of questions, and to provide their subjective response to product demonstrations/concepts. Note that for children, the time used is shorter than the normal 1 to 2 hours focus group session with adults, as 45 minutes to an hour resembles the length of a typical school class. Often children are given tasks to complete with the prototype of the product so that they may have a better frame of reference from which to speak. Presenting the questions or product to a group usually sparks group discussion and can provide more information than interviewing individual alone [10]. Focus groups are best suited to the generation of ideas with children at the initial stage of design.

Questionnaires allow a developer / researcher to ask every child the same questions in a structured manner. These can be administrated on paper or in digital forms; to be given to a class of children, or to be distributed to a large group of children digitally at one time. The advantage of this technique is that it can reach a large demographic however with little room for adaptation. In some design projects, children use questionnaires to contribute ideas and suggestions for future or partially completed de-

signs: e.g. for eliciting their mental models [26] and for gathering requirements for interfaces [9]. There are established guidelines for survey design for children [7]: 1. Keep it short; 2. Pilot the language; 3. Provide assistance for non-readers and poor readers; 4. Limit the writing; 5. User appropriate tools and methods; 6. Make it fun; 7. Expect the unexpected; 8. Don't take it too seriously; and 9. Be nice! The Fun Toolkit is a popular selection of tools that were designed with these guidelines in mind; it use pictures instead of words, and simple children's language instead of technical jargon. The Fun Toolkit consists of a "Smileyometer", a "Fun Sorter" and an "Again-Again table". The toolkit can be used for sampling children's experience, comparing and ranking activities. It is fun and attractive, and reduces some of the effects of satisficing and optimizing. [27]

When it comes to surveying emotions and experiences over time, one approach can be to combine Cultural Probes and Experience Sampling [28], in a design research method for inquiries involving young children in the design of artefacts supporting daily life activities and outside a classroom context [29]. In this study, to sample experiences of a very young child who could not read and write, a probes package including diary/booklet, stickers, a disposable camera, pencils, coloured paper, drawing paper, crayons etc. was used. The difficulties of obtaining self-report by children over time can be overcome by involving parents and by using appropriately defined playful assignments in the form of cultural probes as with Iversen and Nielsen who worked with children 11-13, using mobile phones (digital cultural probes) as a data capture device and found that they provided access to children's everyday lives that was not accessible through other means [30].

4.3 Participatory design, Design Sessions with Children

Participatory design emphasises user participation in the decisions related to computing systems that have an impact on their lives. An important aspect of this approach is that users act as fully empowered participants in the design process. One technique for doing this is to ensure that users have early exposure to the target implementation technology - even if this must be done through coarse-granularity, relatively static mock-ups [31]. Participatory design has been an established method for designing technology for and with users [31, 32] and has become increasing popular for designing with children [33].

As opposed to simply being observed, in participatory design children are directly asked to work with researchers to collaboratively create "low-tech prototypes" out of paper, glue, crayons, and so on. These tools act as an icebreaker for a more comfortable brainstorming session, new technology possibilities that might not have previously been considered can therefore be identified [33, 34].

An early variation on participatory design is Informant Design [14], in which stakeholders like children or teachers are seen as experts or 'native informants' informing designers of key issues related to their experience, helping to develop early design ideas and testing prototypes in development [35]. For example, informant design sessions with children aged 8 to 10 used mixed media in designing the logical, physical and the interaction of tangible technology for a museum environment [36].

There are some participatory design methods and techniques that have been specifically designed for working with children. One example is Cooperative Inquiry [37], which is a framework for research and design with children, which includes three crucial aspects: a multidisciplinary partnership with children; field research that emphasizes understanding context, activities, and artifacts; and iterative low-tech and high-tech prototyping. Another is KidReporter [15], which uses mixed media, combining a number of techniques for eliciting information from children, such as interviews, drawing and making pictures. Participatory Analogy is another technique developed for designing user-centred security for children [38].

Other Innovative Participatory Approaches.

Two recent methodological innovations that are especially developed for working with children, are Drawing Intervention (DI) [39] and Obstructed Theatre [17, 18].

Drawing and sketching has long been a common practice in design, creativity and problem-solving [40], where drawing is seen to belong to the set of 'low-tech', lightweight, communicative and creative tools. Children's drawings are widely used for visualizing ideas in the design processes; e.g. for general requirement gathering [15, 41], Informant Design [14, 36] and Participatory Design [42, 43]. Drawing has advantages in being visual and concrete, without using abstract verbal descriptions [44]. In many cases, drawing has been shown to be useful as a form of low-tech prototyping to allow children (and not only children) to envision and visualise their ideas [34, 36, 45].

In CCI, children's drawings are mostly used as an inquiry tool to elicit children's thoughts and ideas for design and requirements gathering. The drawing activity provides insight into the children's concept, understanding and request of the technologies; they give ideas for future work on the redesign of the systems, concerning the functionality, the content, the types of input and output and the interactions.

Drawing is an inclusive activity; it can be used with children of different ages, gender, language, culture, education, developmental level, etc. An example is a large scale study [46] which had asked over 200 children aged 12 and under across the world to draw their answer to the question: "What would you like your computer or the Internet to do that it can't do right now?". In this case, drawing was used as a universal inquiry tool, overcoming language and cultural barriers, positioning younger people as windows into the future of technology, informing technology experiences of all ages.

In general for working with children, drawing can facilitate communication with them; four different experiments done by [47, 48] demonstrate that children, given the opportunity to draw while they build a narrative, give about TWICE as much accurate, detailed information as those who are not asked to draw. The general usage of drawing can enhance communication through direct visual expression and/or through drawing facilitated verbal expression.

The idea of Obstructed Theatre originated from [49]. In the technique, the research team used a slightly humorous video clip in which one actor described some of the functionality of an interactive device in a conversation with another actor whilst referring to, but not showing, the off-screen interactive device in question [18].

The method is intended to trigger design ideas without biasing the imagination by showing a real object. After the video film, the researchers encouraged 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 magic behaviour fancied and were facilitated to try to convey their ideas with art and craft material [17]. This separation from the physical device allows discussion of functionality without giving 'too much' away during the design briefing stage.

5 Summary, Challenges and Issues

Children and young people are not simply small adults; they have their unique requirement needs for interactive products and services. The methods and approaches introduced in this chapter show the overall trend of requirement gathering with children as being a child-centred mixed-method approach with a focus on their experience. It raises many possibilities for working with children on gathering their unique requirement needs.

To get a richer context and a deeper understanding, very often, a combination of methods and approaches are deployed. For example: a systematic observation followed by a semi-structured interview for the requirement gathering for a museum environment [19]; technology probes for exploratory use, peer discussion and critique followed by focus group sessions for designing technology to reduce teenager energy use [50]; classroom observation followed by surveying (interview and questionnaire) in requirements for the design of a handwriting recognition interface [9]; obstructed theatre, drawing and emoticons survey with observation for gathering requirement for a mobile music device for social inclusion [17]. With some other examples listed in the following table:

Technology or service	**Requirement gathering methods & approaches used**	**Age of children**	**Children as**
Interactive museum environment [19]	Observation, semi-structured interview	5-10	Learner
Design of a VLE (Virtual Learning Environment) [20]	Storyboard and observation	8-12	Learner
Computer mediated communication for children and families [22]	Video prototyping, Participatory Design and Cooperative Design	3+	User
Technology to reduce teenager energy use ([50]	Technology probes for exploratory use, peer discussion and critique followed by focus group sessions	10+	User
School classroom Software for encouraging collaborative working [23]	Observation, Brainstorming with low-tech prototyping and storyboarding	7-10	Learner and User
Interactive educational game [15]	KidReporter that combines many techniques like interviews, drawing and making pictures	9-10	Player and Learner
Game-Based Learning Environments	User interface (UI) drawings, idea	7-9	Player

[11]	maps, and evaluations of existing learning environments	11-12	and Learner
Electronic school bag (eBag) for a shared narrative space [24]	Mission from Mars	10-11	Player and User
Affective input-device design (SenToy) [21]	Wizard of Oz prototyping	14+	Player and User
Handwriting recognition interface [9]	classroom observation followed by surveying (interview and questionnaire)	6-7	Player, Learner and User
Mobile music device for social inclusion [17]	obstructed theatre, drawing and emoticons survey with observation	5-10	Player, Learner and User

Table 1. Requirement Gathering Methods and Approaches, Examples in Practice

However there are challenges and issues that arise when choosing the most suitable requirement gathering methods and carrying out work in practice:

- Balancing different requirement needs, e.g. for fun, learning, and communication (use); that meet the interests of all stakeholders.
- Ensuring that the methods and approaches for children are playful, motivating and stimulating; child-appropriate and suited for their reading and writing levels, and their preferences for expressing themselves in different ways, e.g. verbally or non-verbally.
- Combining diverse data to optimise the data quality. With adults, but possibly more so with children, it is important to check for consistency of answers, by gathering similar information from different sources. For example, using various methods such as interviews, observations and diary methods.
- Ensuring the technique results in useful information for the design of targeted applications, e.g. on educational games, tangible technology, small devices, mobile, distributed app, service development etc.

To summarise: gathering ideas from children early in the design process has yielded useful insights into what children want in technology in general or in a specific type of application. Druin et al. [12], for example, discovered that children want control, variety, social interaction, and creative tools, and that they pay attention to the appearance, learnability, and "coolness" of an application, as well as on how rich it is in terms of the use of multimedia. Children's early involvement in requirements gathering has revealed clues also about, for example, gender differences in preferences related to technology, children's navigation skills, ways of presenting textual information, application-specific content related preferences, the variety of elements to be included in user interfaces and their structures, and children's desire to personalize their applications [11, 15, 20, 23, 24, 51, 52].

6 Conclusion

Nowadays the design and development of children's and young people's technologies has been focusing on their experience at home, school and public spaces. Research into their requirement needs as Player, Learner and User (PLU) are one of the main themes in Interaction Design for Children (IDC).

This chapter introduces this unique research domain, presents an overview of the current practice in requirement gathering with children and young people. It shows a variety of common methods and approaches, and child-appropriate methodological innovation in the current research. This:

- Presents a broad range of requirement gathering methods and approaches;
- Provides insights on when to apply the various requirement gathering methods for various requirements and shows how methods can be also applied to a more general HCI context;
- Includes new research on requirement gathering methodological innovations applicable for novel technologies, e.g. Tangible Technologies (TanTech) and portable devices;
- Describes new methodological innovations;

This chapter hopes to give an overview for researchers and practitioners in the field for carrying out requirement gathering research with children and young people.

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