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EVALUATION OF CONSTRUCT ELICITATION AS A RESEARCH METHOD TO OBTAIN DESIGN-RELEVANT DATA FROM CHILDREN

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1. This study is part of the ongoing doctoral research of the first author, supervised by the second author. A previous study exploring the potential of open-ended techniques for eliciting design-relevant constructs from children was published in Süner and Erbuğ, 2014.

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INTRODUCTION

In design research, the importance of the input of children is well-recognized. Technology has immersed into schools and daily lives of children, bringing with it adaption of user-centered design principles in the field. Although early works concentrated mostly on usability testing (Hanna et al., 1997), methodological approaches that involve children in the earlier design phases have also been gaining popularity. Methods such as “informant design” (Scaife and Rogers, 1999) and “contextual inquiry” (Druin, 2002) aim to ensure the maximum contribution of children through sustained participation. Generative tools and techniques such as collages and stickers (Gielen, 2008), “write/draw task” and “photo voice” (Hussain, 2010) and “KidReporter” (Bekker et al., 2003) also help designers to better understand children’s needs. That said, the majority of studies in the field have sought to garner children’s opinions in the testing phase (Jensen and Skov, 2005; Yarosh et al., 2010) rather than attempting to integrate their subjective perspectives into major design decisions, which limits the contributions of children to usability improvement. User experience, however, goes beyond usability, embodying hedonic as well as pragmatic aspects of the interaction of the user with the product (Hassenzahl, 2004), and acknowledges the importance of social and cultural aspects in the ways we experience products (Forlizzi and Ford, 2000).

The aim of this study is to explore the potential of a construct elicitation method adapted from Repertory Grid Technique (RGT) as a tool for the exploration of the experiences of child users (**1**). Having roots in Personal Construct Theory (PCT), RGT is expected to uncover the subjective construing systems of young users about the investigated product experience, allowing the generation of design-relevant information. The paper is structured as follows: first, a systematic review is made of research trends related to the involvement of children in the design process; after which, the characteristics of RGT and its feasibility as a tool for the investigation of user experiences of children will be discussed. Lastly, we present our explorative study and its results, and discuss the methodological implications of the study.

THE ROLE OF CHILDREN IN DESIGN

As technology becomes inseparable from the educational and the daily lives of children, a consensus is growing in the importance of taking young users' needs into consideration in design processes. Not only the expectations of adults, but also their perception of children's expectations from designed products are likely to differ than those of children (Good and Robertson, 2006). This concern has tended to be well-received, especially in the interaction design community, and methodological perspectives have been maturing day-by-day. In approaches that range from reactive contribution of children in usability testing to more initiative approaches, such as participatory techniques, children are taking up a role, one way or another, in the creation of the technological products being designed for them.

Druin (2002) defines the role of children in the technology design process as being one of user, tester, informant and design partner. This categorization marks not only methods, but also the level of input by children into the design process. When children are included as testers, they can play a role in the improvement of usability issues or stylistic decisions. If included in the earlier phases, for instance, as design partners, they are given the opportunity to have a voice in major design decisions. Despite the growing interest in including end users in technology design for children, the majority of works still limit their involvement in the process to the role of testers of the designed products and systems in the later phases of the design process. In their review of research methods in technology design for children, Jensen and Skov (2005) found that 67% of the reviewed papers had included evaluations with children. This apparent bias towards the evaluation of engineered products remains as an issue to be addressed can be seen in Yarosh et al.'s (2011) review of the Interaction Design and Children (IDC) conference papers, which found that 59% of the studies involved children as testers of the designed products and systems.

We carried out a systematic literature survey to understand the general research trends in design research involving children, and although this is a work in progress, the methodology and the initial findings can be shared and discussed. In this preliminary work, full papers of Interaction Design and Children (IDC) conferences were reviewed and categorized in terms of the role of children in the design, and at which stage of the design process the user research with children was conducted. The IDC conference was selected as a starting point for the study for three reasons. First, IDC, which has been held annually since 2002, is a prestigious conference and the only academic event focusing fully on design for children. Second, it aims to bring together not only user research activities to understand children's needs, but also design implications, embodying the diversity of the field by bringing forth discussions on both research and practice. Finally, it has a meticulous paper selection process with an average acceptance rate of 23% (ACM Digital Library statistics).

Methodology of the Literature Survey

The data for this preliminary review came from full papers submitted to the IDC conference between 2011 and 2015. Since Yarosh et al.'s (2011) study covers IDC papers published between 2002 and 2010, included in this review were papers published after this date up until the time of writing of this paper. Our aim was to understand the trends in the IDC community in terms of the roles given to children in design research, and how this information is utilized in design processes. For this purpose, we sought to answer the following questions:

- At which design stage was the reported user research implemented?
- To what extent did users contribute to the research and/or design process?

To investigate both the role of children and how their input is utilized in the design process, we included only the papers that reported on both user research with the target group and its design implications. Of all the 105 full papers published in the five years between 2011 and 2015, 87 papers were found to report on both the research and design, and were thus included in the analysis. A few papers reported on more than one user research, typically one before/during the design phase, and one in post-design testing. In such cases, both studies were included in the analysis, but only if they both reported a detailed user research methodology.

Each paper was subjected to content analysis, a qualitative data treatment approach, appropriate for the classification of textual, visual or similar symbolic data (Krippendorf, 2004). All papers were coded with constructs under two main categories: (1) the phase of design during which user research is applied, and (2) degree of participation of the end users in the design. Following the categorizations put forward in existing literature (Squires, 2002; Wickens et al., 2004; Blythe et al., 2007), the papers were coded according to the following constructs to define the design phase: testing, idea generation and pre-design. For the degree of participation, we used Druin's (2002) framework to define the roles of tester, informant and design partner. Each construct is explained in **Table 1.**

Construct	Explanation
Design phase	
Pre-design	Children are consulted at the 'fuzzy front-end' of the design phase preceding idea generation, and on some occasions, preceding even the design brief
Idea generation	User research is conducted during the idea generation phase, typically for the purpose of evaluating the design concepts and re-defining the following design decisions.
Testing	User research is conducted in a later design phase to evaluate the design solution for minor changes, such as usability improvement
Degree of participation	
Design partner	Children take a direct and ideally equal role in generating design ideas
Informant	The input provided by children has an impact on major design decisions
Tester	Children test/evaluate the developed product or system

Table 1. Construct list used in literature survey

	Testing	Idea gen.	Pre-design	TOTAL
Tester	59	9	-	**68**
Informant	-	8	13	**21**
Design part.	-	3	9	**12**
TOTAL	**59**	**20**	**22**	**101**

Table 2. Categorization of the IDC papers

Analysis and Results

Table 2 presents the results of the content analysis. Among the 87 reviewed papers, 10 reported more than one user research at different phases of the design process. Furthermore, some of the reported user researches involved children in more than one role (for example, as both informant and tester). This variety is a result of the iterative nature of the design process, in which more than one user study is conducted in different phases. When this is the case, the paper was coded with all reported design phases and user roles, which explains why the total number of design phases and user roles (101) shown in the table are greater than the number of reviewed papers (87).

In around 68% of the studies, children were invited to test and evaluate design solutions, while the rest utilized their knowledge either as informants or design partners. Similarly, the majority of the studies reported user research in the testing phase (59%), although these percentages include studies that reported on multiple user roles in different design phases. In 55% of the 87 papers, user research was conducted only in the testing phase, while in 62% of the papers, children were only given the role of testers during either testing or idea generation phase.

Although a broader survey including diverse publication venues is required to obtain more definitive results, these findings are consistent with those of Yarosh et al. (2011) and Jensen and Skov (2005), showing an apparent bias towards the inclusion of children in later phases of the design process as evaluators of the designed solutions, rather than incorporating their self-reported needs and values into the defining of major design decisions in the earlier phases. There would appear to be a tendency to rely on developmental theories and the expert opinions of educators in the early phases of the design, and to lean on the opportunities provided by novel technologies. The input of children, on the other hand, tends to remain limited to their observed interactions with the design solutions for usability improvement, or for the measurement of the educational impact of interaction with the products and systems.

Although user testing is an important method in user-centered design approach, this situation highlights technology and expert opinion as the main sources of novelty in design, while the opportunity for user-centered innovation is overshadowed. Participatory design (Sanders, 2002) and design ethnography (Salvador et al., 1999) are popular approaches to enable the transfer of tacit user knowledge into design solutions. Despite the value to designers of gaining first-hand knowledge on user experience, it is not always applicable under the current market conditions (Van Veggel, 2005). Participatory methods are often reported to be demanding on time and resources (Antle, 2003), and reported project durations have been seen to take up to several months or even years. Ethnographic methods, if designers do not have the chance to directly engage with users, may lead to problems in the mediation of this rich contextual data to designers (Hughes et al., 1997). An approach that benefits from the user information as a main source in exploring the possibilities in the design space rather than focusing on pre-defined and to-be-fixed problems would be beneficial to design. This would be possible by taking a holistic approach to understand the experiences of children, paving the way for the discovery of unexplored spaces in children's lives through their eyes.

USER EXPERIENCE AND STUDY OF PERCEIVED PRODUCT EXPERIENCE

Unlike usability improvement and measurement of the impact of design solutions, exploration of user experience requires investigating beyond the utility of a product. User experience embodies the totality of psychological, social and cultural aspects of product experience. According to Hassenzahl (2004), experience with a product is identified through a set of goal-oriented (pragmatic) and self-oriented (hedonic) attributes, while Desmet and Hekkert (2007) refer to the sensory, symbolic and emotional aspects of experience. In their model of human-product interaction, Hekkert and Schifferstein (2008) emphasize biological and psychological factors in the way we experience products, while social and cultural factors (Forlizzi and Ford, 2000) as well as momentary situations (Hassenzahl, 2003) are also influential in how users perceive and experience products.

The frameworks of user experience bear similarities with models of product perception in their emphasis on the subjectivity of experience. Studies of perceived product attributes are well grounded in marketing research. Gutman (1982) propose means-end chain model to understand how perceived product attributes are linked to abstract customer values through mental categorizations. According to his model, tangible product attributes (means) create certain physical or psychological consequences, leading to either satisfaction or dissatisfaction of high-order personal values. The significance of means-end chain and similar models for design research lie in conceptualizing how certain product attributes are associated with subjective meanings. According to Bloch (1995), users make judgements about products even based solely on their forms through certain mental categories regarding what the product has to offer, and this judgement stems from previous experiences and existing construct systems, affecting how we engage in future experiences with products. Similarly, Crilly et al. (2004) define the visual consumption of products as a communication process, with the final destination being the end-user who interprets and judges the products based on tangible stimuli and previous knowledge.

Warell (2008) highlights the importance of gaining a better understanding of how products are and maybe experienced by users, since this allows designers to close the gap between the intended meaning presented by the designer and meaning perceived by the user, hence, designing products for pleasurable and meaningful experiences. His work on perceptual experience also bears similarities with means-end chain model, and he describes the perceptual product experience process at three levels: (i) recognition, referring to the direct stimuli received from a product, (ii) comprehension, focusing on the semantics of the product by making sense of this stimuli, and finally (iii) association, being the symbolic level of how products are conditioned based on socio-cultural norms. This process is also consistent with Crilly et al.'s (2004) model of cognitive response to design on aesthetic, semantic and symbolic levels.

Integrating the aforementioned frameworks and models, it is possible to identify the inter-relation of three spaces: (1) designer's space, in which the product is shaped within an intentional decision-making process; (2) user's space, which consists of an individual background of biological and psychological factors, as well as past experiences, and (3) usage context, being the situation in which the product is experienced, including all physical, social and cultural conditions. Designers apply product features in an attempt to initiate certain experiences, though the actual experience is conditioned by not only these features, but also by factors of user space and usage context. Although designers cannot control either individual or contextual factors, they need to have a good grasp of them if they are to take an influential role in the decision-making process to initiate the intended experiences (Forlizzi and Ford, 2000). In this way, it may be possible to close the gap between the intended product features and the consequences experienced by the users.

Sorting procedures, laddering and Repertory Grid Technique (RGT) are among the suggested means of exploring the relationship between perceived product attributes and related values (Gutman, 1982, 71). Scrutinizing these complicated cognitive schemes can help in identifying patterns between tangible product attributes and user-centered meanings, leading to a better understanding and prediction of how users do and possibly will engage with products. Such an approach to user research will help produce valuable information on the product-related meanings of users, thus making an important contribution to new product development process (Töre Yargın and Erbuğ, 2012).

EXPLORING USER EXPERIENCE THROUGH ELICITING PERSONAL CONSTRUCTS

RGT has a theoretical grounding in Personal Construct Theory (PCT), which explains its ability to unravel personal cognitive structures in any domain, such as people, environments, objects, etc. (Fransella and Neimeyer, 2003). According to PCT, personal construing system is based on previous experiences, affecting subjective values and judgements, as well as how people anticipate future experiences (Kelly, 2003; Fransella et al., 2004). According to PCT, our construing is channelized, meaning that it is permeable and dynamic, and able to adapt as we encounter new events (Kelly, 2003). In this regard, PCT is not about 'fully formed minds', but rather sees people of all ages as scientists seeking meaning through their construing (Butler and Green, 2007). Since all people are in motion, PCT is not interested in stage-like child development theories (Fransella and Neimeyer, 2003), which is why there is no age limit to the investigation of personal construction systems. In this regard, RGT, being a clinical tool of PCT, is applicable even with young children (Fransella et al., 2004).

RGT is fundamentally a structured interview technique. A repertory grid comprises a topic (i.e. fun in video games), elements (i.e. various video games), bipolar constructs (dimensions which make video games fun or not fun) and ratings of each element in relation to each construct. Elements and constructs may be supplied or elicited from the interviewee. In a typical interview procedure, different elements are compared for similarities and differences in groups of three (triad), and this process results in the naming of a number of personal bipolar constructs through which the individual gives meaning to the topic in question. The session ends with rating of the elements for each construct. Constructs are always bipolar (i.e. exciting/

dull), in that an originally named construct (exciting) is only complete with a construct pole (dull), and together they serve as a scale by which each element is evaluated and positioned.

RGT not only provides design-relevant information from user's point of view, but also enables researchers to explore design possibilities through the user's own mental models (Hassenzahl and Wessler, 2000; Verlinden and Coenders, 2000). RGT is often described as a "value-free" technique that allows an exploration of subjective experiences from the personal point of view of an individual with minimum researcher bias (Fransella and Neimeyer, 2003; Alexander and Van Loggerenberg, 2005). It is "an attempt to stand in others' shoes, to see their world as they see it, and to understand their situation and their concerns" (Fransella et al., 2004, 6). Given the tendency to investigate the experiences of children as filtered through adult perspectives, the importance of understanding children's needs and aspirations without pre-defined criteria comes to the forefront. The clinical tools of PCT help us to "understand children's understanding", which requires finding a way of looking at how children create meaning from the inside-out rather than from the outside-in (Butler and Green, 2007).

RGT has the power to reveal tacit knowledge and subjective meaning structures related to the experience in question. While bringing to the surface in-depth, subjective perspectives, it also helps identify meaningful patterns between various dimensions effecting user experience. Eliciting such tacit meanings is an important input for design of novel products (Öberg and Verganti, 2012). Furthermore, RGT is a structured yet flexible procedure that is appropriate for various research contexts (topic), being applicable to almost any artifact (elements), and able to unravel both pragmatic and hedonic aspects of experience (constructs) in a holistic way. It is possible to integrate products, images, lo-fi or hi-fi prototypes, and conceptual sketches into the data gathering procedure as elements. This flexibility gives researchers the power to adapt the methodology to various research settings. Studies of user experience researches have shown that RGT has been utilized not only for overall product evaluation (Hassenzahl and Trautmann, 2001; Khan, 2012), but also to elicit the dimensions of user-product experience (Steed and McDonnell, 2003; Fallman and Waterworth, 2010; Karahanoglu and Erbug, 2011).

Laddering, being devised as a procedure within RGT, is a strong tool for the eliciting of in-depth, value-laden "superordinate" constructs (Fransella, 2003). Having a wider range of convenience, laddered constructs are central, and more resistant to change (Jankowicz, 2004). Although being a structured technique, laddering generates richer and more in-depth information when compared to quantitative methods of data gathering, and yet is easier to conduct than unstructured techniques, since it is the researcher who decides which constructs to elaborate by laddering. Laddering has been utilized in marketing research to explore the relationship between product attributes and the attached consequences and values (Gutman, 1982). Although the use of RGT is comparatively new in design research with children, laddering has gained more popularity, having been utilized successfully in user experience research with children (Zaman, 2008; Zaman and Abeele, 2010; Celis et al., 2013; Saarinen et al., 2013).

As a result of these characteristics, a construct elicitation methodology based on RGT and incorporating a laddering procedure is considered an eligible tool for the exploration of the product experiences of children.

2. The methodology of this study was briefly presented in a previous proceeding: Süner, Erbuğ, 2014b.

Since the use of RGT for the purpose of understanding children's user experience has not been investigated in detail before, this explorative study is expected to illuminate possible opportunities for further research.

METHODOLOGY

An explorative study was conducted to investigate the potential of construct elicitation as a means of gaining a holistic description of the perceived product experience of children (**2**). The study was designed to source answers to the following questions:

- In what ways can and should the RGT process be modified to elicit children's constructs of perceived product experience?
- Which aspects of children's perceived product experience can be revealed through the proposed methodology?

We chose to investigate mobile phone experience for three reasons: (i) the current market for use by children is dominated by products aimed at allaying the security concerns of parents, rather than designs to satisfy children's expectations; (ii) despite the lack of product options for children in the local market, children are familiar with mobile phones of various models in their social environment; and (iii) mobile phones embody pragmatic as well as hedonic aspects of experience, being designed for personal use, but is also a showcase product, being consumed in the social space.

Participants

Prior to the main study, a pilot study was carried out in the Utest usability lab in Middle East Technical University, Department of Industrial Design. The aim of the pilot study was to test the applicability of the interview procedure and to determine the age group in the main study sample. For the pilot study, we recruited seven children sourced by word-of-mouth, three of which were in preschool (5 to 6 years old), and four who were first-grade students in the second semester (6 to 7 years old). This age group represents the transition from preoperational to concrete operational stage in Piagetian terms, characterized by the development of such intellectual abilities as making categorizations, sorting objects by features, inductive thinking and understanding causality (Piaget, 2001). Although PCT theoretically rules out developmental maturity as a prerequisite in personal construing, RGT and laddering procedures require an understanding of such concepts, since the procedure includes categorizations based on similarities and differences, ranking by features, and induction from product attributes to consequences.

In the pilot study, we observed that schooled children were more confident in following the interview procedure, and for this reason, we conducted the main study with students from one first grade class and one second grade class (6 to 8 years old, n=44) in a local public primary school. The initial number of participants in the study was 46, although one of the participants had difficulty in understanding the research protocol, and one was hearing-disabled, making verbal communication difficult, and so they were removed from data set. We obtained approval from Middle East Technical University Applied Ethics Research Center, permission from the Ministry of National Education and oral consent from each participant.

Figure 1. Product image cards used in the study

Selection of Products

The elements (products) utilized in RGT procedure are of significant importance, since the entire construct elicitation process is based on their comparison. The representativeness and range of convenience of each item should be taken into consideration in the selection of elements, which means they should represent the diversity of the topic while remaining within the range of the investigated area (Fransella et al., 2004). In our study, we decided to include mobile phones designed specifically for children as well as those for adult consumers. In providing such diversity, we expected to elicit a wider range of constructs since a comparison of elements in terms of both similarities and differences constitutes the basis of the elicitation process. Apart from the targeted user group, we also considered ensuring diversity in the forms and interactive features of the products.

Visual representations of products have proven useful as probes when aiming to concretize explored attributes when studying perceived product experience (Töre Yargın and Erbuğ, 2012; Kuru and Erbuğ, 2013). The set of product image cards used as elements in the interview are shown in **Figure 1**. P1, P2, and P3 are designed specifically for children, with target ages ranging from preschool to preteen years. P4 and P5 are full spectrum smart phones that are designed for adult users. The brand names of all phones were erased using photo manipulation software, and the images were printed in real size proportions.

Figure 2. Sample interview setting

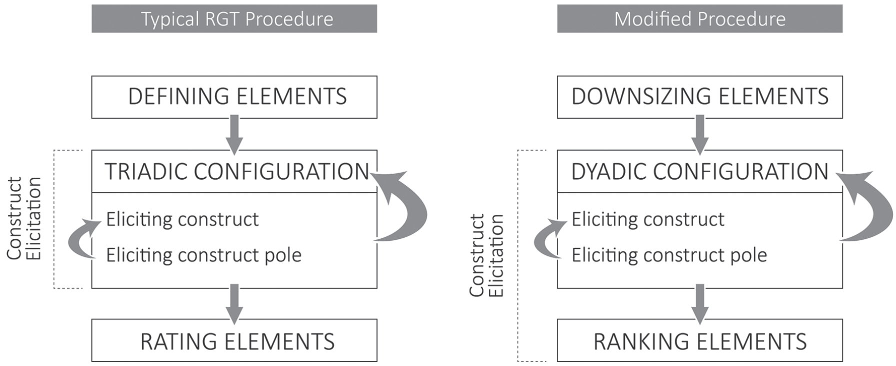

Figure 3. Data collection procedure

Procedure

Before starting the interviews, the teachers introduced the researcher to the class and explained the procedure. Individual interviews were conducted in a private space in the school library by the first author during regular class time over the course of two weeks. **Figure 2** shows a sample interview setting. Each session was recorded with a digital video camera for analysis.

The interviews started with a chat about mobile phones to sensitize the participants after which they were told that our aim was to design a mobile phone for kids, and we invited them to help us by sharing their opinions. The interview started only after the participant had agreed to participate. Although interview protocol is based on RGT interview procedure, we modified it as summarized in **Figure 3** to fit to our research setting better. In a typical RGT interview, elements may either be elicited from the interviewee or supplied by the researcher. In user research, elements are mostly supplied, since they are usually products that are to be compared. Although we supplied the elements, we began the procedure with downsizing, which also functioned as a warm-up. We asked the participant to rank the phones in likeability order, and picked the most, mid, and the least liked elements for the next construct elicitation phase. The intention in this regard was to randomize the configuration while maintaining diversity in the compared elements, since it would be quite tiresome to compare every possible combination of elements in construct elicitation.

Our construct elicitation and rating procedure differs from typical uses of RGT in three ways. First, although triadic configuration is the most popular method for eliciting constructs, we preferred to adopt dyadic configuration. In triadic configuration, elements are presented to the interviewee in groups of three and the participant is asked to articulate the similarities and differences, which constitute the constructs. This process may be cognitively demanding, and so dyadic configuration is often suggested to be more suitable for children (Fransella et al., 2004; Butler and Green, 2007). Dyadic elicitation is similar to triadic one, although the elements are presented rather in pairs. When eliciting the construct poles that complement the elicited construct (i.e. fun/boring, serious/childish), we followed a similar procedure by asking simply: “What would you call something that is not fun?”, or, if the construct comes to stating a difference between two elements: “So you think this one is fun, what do you make of the other one, then?”

Laddering procedure was applied for each elicited construct. If the expressed construct was a concrete one (i.e. has a bigger screen), the participant was asked whether it was a desirable thing or not to define the pole, and then asked the question *why* to understand what consequence it would be associated with until he or she cannot come up with different constructs (i.e. you can see the apps on the screen > you can find anything you want). If the first expressed construct is an abstract one, then we started laddering down using a procedure known as pyramiding (Butler and Green, 2007) to understand which attributes determine that particular consequence by asking how questions. In some cases, the procedure included a combination of both (i.e. has a bigger screen > fun > because you can play games).

Despite the common application, we utilized ranking rather than rating elements, with rating being the phase during which elements are rated for each bipolar construct. Salmon (1976) recommends ranking rather than rating for children younger than 12, suggesting that it is comparatively easier to do so through physical ranking (i.e. cards) than through a verbal approach. We followed a similar procedure, asking children to rank the product image cards on a scale indicated by the constructs (i.e. for adults/ toy-like). In a final modification to the procedure, we distributed construct elicitation throughout the dyadic configuration and ranking phases. Since dyadic elicitation is conducted with three product cards, the other two cards are included in the ranking phase. Through distributed elicitation, we expected to maximize the number and diversity of the constructs.

The durations of the interviews ranged between 12 and 35 minutes, with an average of 21 minutes. In the end, we had approximately 15 hours of video and 44 grid sheets on which the elicited constructs and rankings were noted during the interviews.

Analysis

Typically, RGT enables both qualitative and quantitative analyses. The qualitative part is the content analysis of the participant statements, while the ratings/rankings form the basis of a statistical analysis. However, Kuru (2015) states in her comparative study of the two forms of analysis that quantitative analysis of multiple user data results in data reduction, and so recommends quantitative analysis for user testing, while qualitative analysis is found to be more useful in generating in-depth information to inform early design phases. For this reason, we utilized content analysis for data treatment.

The video recordings of each interview were transcribed and divided into laddered constructs and related statements. Since our aim was to understand the relationship between perceived product attributes and attached meanings, we applied content analysis by coding (1) the product attribute in question (i.e. has touch screen -> control type), and the (2) causal and (3) effected consequences of this attribute in terms of perceived experience (i.e. ease of use -> gamability). **Figure 4** presents examples of this open coding process of the given statements. In order to prevent distortion, repetitions of the same attribute -> causal -> effected chain by

Construct		Statement	Talking About	Product Attribute	Causal	Effected
for kids	for adults	It is bad to have these ears. No way has a phone ears! Looks like it is something for kids [P2].	has ear-like parts	body form	personification	age appropriateness
easy to find things	difficult to find things	[P5] has this square button, so easier than [P1]. We first push the square and it is on, then we say "mmm there is some stuff here."	has visible menu button	control type	visibility	accessibility

Figure 4. Sample coding

Dimension	Explanation
Accessibility	Ease of navigation through the menu, screen or within particular apps
Aesthetic appeal	Being visually pleasant and appealing
Age appropriateness	Being suitable for use by a specific age group, such as children or the elderly
Audibility	Audio quality, volume level, etc.
Durability	Physical and technical endurance
Ease of use	Ease in use of a particular application or task completion
Familiarity	Previous experience or familiarity with the product or certain features
Fun	Being entertaining in qualities, applications or looks
Gamability	Enabling a satisfactory gaming experience
Personification	Having a person-like "character" as a result of physical form features
Multifunctionality	The extent of functions and technical capacities of the product
Novelty	Being new, original and state-of-the-art
Portability	Ease in handling and carrying the product
Product expression	Looks, resemblances, expressions
Readability	Ease in reading the written items and images
Understandability	Being cognitively compatible with the user
Visibility	Visibility and clarity of controls
Writability	Ease in writing texts

Table 3. Dimensions of child-mobile phone experience

the same user were omitted. In total, 881 ladders emerged from 267 elicited constructs (approximately six constructs per participant).

RESULTS

The laddering procedure applied in the interviews led the content analysis to identify the links between perceived product attributes and their consequences, as well as between the consequences themselves. We refer to these emerging consequences as dimensions of the perceived experience.

The content analysis of the data resulted in 18 perceived user experience dimensions that included both pragmatic concerns, such as ease of use, understandability and accessibility, and hedonic aspects, such as aesthetic appeal, product expression and fun. The content of each dimension is explained in **Table 3**. Our aim is now to present the results in a way that represents the multidimensionality among the product attributes and dimensions.

Perceived Dimensions of Mobile Phone Experience

Some of the emerged perceived dimensions listed in the table have a significant impact on other dimensions, while others are relatively independent. In order to show these impact-dependency levels, we utilized cross-impact analysis (CIA). CIA is an analysis method for future forecasting, since it defines potential events and the relationships between them (Gordon, 1994). CIA displays the impact of various dimensions in a holistic way, making it possible to see the effects of potential changes

	EFFECTED (dependency)																		
CAUSAL (impact)	accessibility	aesthetic appeal	age appropriateness	audibility	durability	ease of use	familiarity	fun	gamability	multifunctionality	novelty	personification	portability	product expression	readibility	understandibility	visibility	writability	TOTAL
accessibility	7		1			41		2	13	9	3				3			2	81
aesthetic appeal		46	1					1			2								50
age appropriateness			1																1
audibility			2	26		1													29
durability		1			16													1	18
ease of use	1		2		2	31			25	2	1				4			24	92
familiarity	2	15	2	5	2	11	47	1	9	4	4		1	1		5		2	111
fun			3					4											7
gamability			3				1	2	12										18
multifunctionality	1		3	1			5	2	1	21	8								42
novelty		4		2				1	3	7	9								26
personification		15	4				10	1				2		1					33
portability		1	3		1	1	1						54						61
product expression		19	9		1		19	3			5		2	1					59
readability	4	2	3			5	2		5		1				45	1		2	70
understandability	6	2	2	1		18	3		6	1	2					3		3	47
visibility	57					19	2		1	6						3	1	22	111
writability	1				1	13		3	3									4	25
TOTAL	72	59	38	9	7	109	43	16	66	29	26	0	3	2	7	9	0	56	

Figure 5. Cross-impact matrix

and interventions within the system, rather than merely evaluating them (Salevsky and Müller, 2011). Identifying patterns of relations between minor and major factors within the system, CIA in user research is put forward as an effective way of analyzing and somewhat quantifying qualitative RGT data, and visualizing it in a meaningful way for the benefit of designers (Kuru and Erbuğ, 2013; Kuru, 2015).

We entered the impact-dependency relationships into a table to produce a cross-impact matrix (**Figure 5**) that shows the impact and dependency levels of each dimension based on the frequencies of the participant statements. Each row in the chart shows the impact level of the dimension on others, while the columns represent how much each dimension is effected by others. Values in gray cells indicate the frequency of the dimensions without being causal of another one, meaning that the participant linked it with a particular product attribute (i.e. body color -> aesthetic appeal), but not with another dimension. Accordingly, these values are added to impact total, but not to the dependency total.

Perceived ease of use, for instance, significantly both effects (impact) and is effected by (dependency) the dimensions in the system, while age appropriateness is essentially effected. Based on the impact and dependency levels in the matrix, a cross-impact chart was created to visualize the hierarchy of the dimensions in the system (**Figure 6**).

The cross-impact chart consists of five areas. The critical area represents the highly influential and dependent dimensions, which means any intervention towards them will have a significant effect on the whole system. The active dimensions are rather independent; they largely influence others, while remain relatively unaffected by them. The reactive

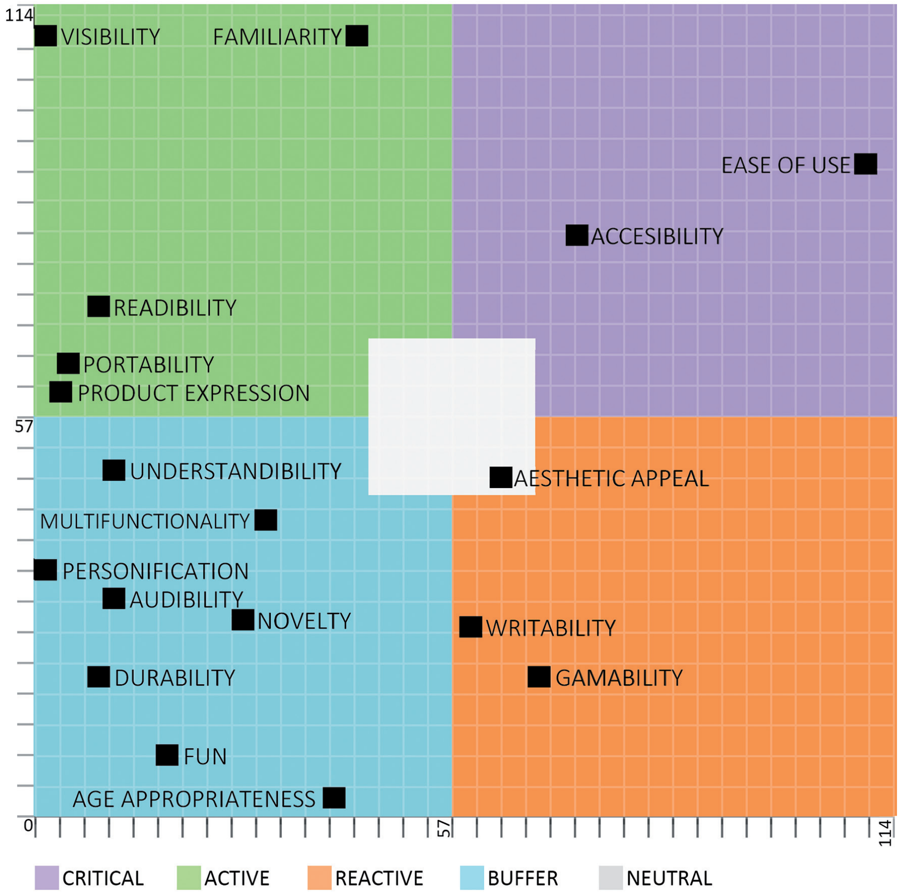

Figure 6. Cross-impact chart

dimensions are mostly dependent on others, while having less impact. The neutral area has moderate impact and dependency, while the relationships of the buffer dimensions with others in the system are relatively loose, although this does not mean that they are to be ignored in the design process. The cross-impact chart represents the system in balance. Although the individual impact and dependency of buffer dimensions are less significant, they might be in strong relationship with particular dimensions (Kuru, 2015).

The value of the cross-impact chart is that it provides a quick overview of the factors influencing product experience from users' point of view in a holistic and hierarchical way. The links between dimensions, however, are not represented in the chart, and reflecting such relationships is important in minimizing data reduction. The chart may also make a valid contribution to the designer's understanding of the mental models of children regarding the product experience in question, for which we constructed a map based on the impact-dependency levels presented in the cross-impact matrix (**Figure 7**).

The cross-impact map allows us to observe the level of importance among the dimensions indicated by the diameters of the circles, and also the strength of the relationship between dimensions indicated by the relative thickness of the links. Both diameters and thicknesses represent the frequencies shown in the cross-impact matrix. We also adopted color-coding technique in the cross-impact chart to represent the areas. The map shows clusters of dimensions in relation to each other. Based on

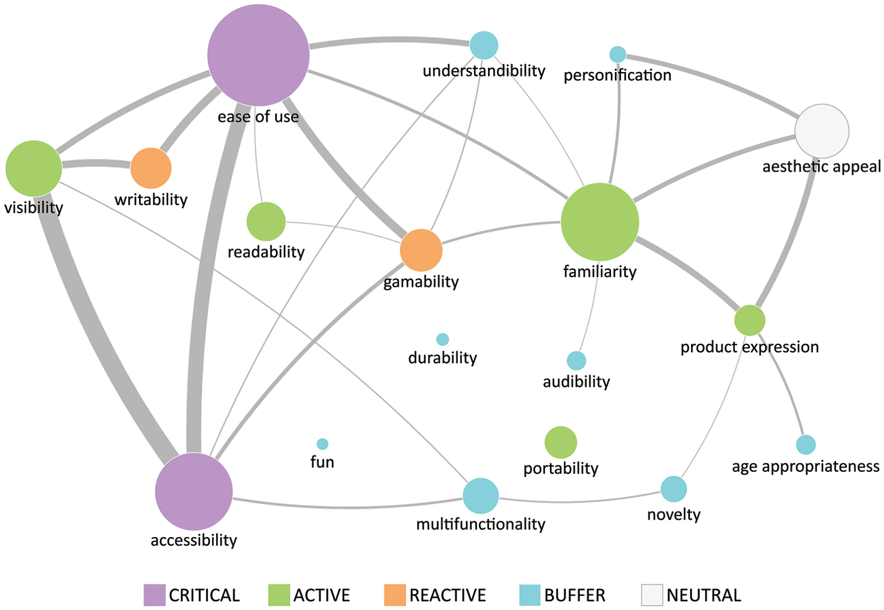

Figure 7. Cross-impact map (cut-off value=5)

Hassenzahl's (2004) categorization, the right area of the map is dominated by hedonic dimensions, while the left area comprises mostly pragmatic aspects. The placement of familiarity is of particular note, having a balanced relationship with both the hedonic and pragmatic dimensions, which is information that is not visible in the cross-impact chart.

The map visualizes potential points of design intervention. For instance, in order to develop an easy-to-use mobile phone for children, designers should pay particular attention to accessibility, visibility, writability, and so on. Similarly, significant connections can be observed between product expression, familiarity and aesthetic appeal. Relatively independent dimensions, such as audibility and age appropriateness, are also displayed on the map. Being independent does not necessarily mean independence from the system itself, but shows that it is more likely to be a consequence of a product attribute rather than other dimensions. It would also appear that some of the buffering dimensions in the cross-impact matrix have relatively weaker but yet considerable links with other dimensions. Understandability, for instance, is related to ease of use, familiarity and gamability. This shows consistency with Kuru (2015), who draws attention to the balanced nature of the cross-impact chart, and recommends designers pay heed to the buffering dimensions.

Perceived Product Attributes Affecting Dimensions of Mobile Phone Experience

The cross-impact analysis represent the aspects of the perceived product experience from user's perspective, while missing how these aspects are related to actual product attributes. Concrete exemplification of the abstracted dimensions would provide valuable guidance for designers, since it informs the design process by establishing the potential consequences of particular product features (Töre Yargın, 2013). This information can be obtained from our data, and has already been included in the coding process in the form of product attributes and attached consequences. Another matrix was created to show the impact of product attributes on the aforementioned dimensions (**Figure 8**), in which the

CONSEQUENCE \ ATTRIBUTE	application	body color	body form	body material	body size	control color	control layout	control number	control size	control type	screen color	screen size	TOTAL
accessibility	30	0	0	0	2	2	22	13	1	62	1	16	149
aesthetic appeal	7	28	28	6	3	2	1	1	0	5	22	6	109
age appropriateness	7	4	7	0	6	0	0	2	1	6	0	3	36
audibility	1	0	27	0	0	0	0	1	0	1	0	3	33
durability	1	0	6	8	1	0	3	1	0	4	0	0	24
ease of use	13	0	2	0	2	3	22	51	10	74	1	16	194
familiarity	8	8	42	3	5	1	1	17	2	32	2	2	123
fun	5	1	2	1	1	2	0	4	0	5	0	0	21
gamability	12	0	0	0	0	0	3	14	1	37	2	8	77
multifunctionality	30	0	0	1	4	0	0	18	0	5	1	8	67
novelty	10	1	2	6	2	0	0	5	0	10	1	1	38
personification	0	0	32	1	0	0	0	0	0	0	0	0	33
portability	0	0	35	2	25	0	1	0	0	0	0	0	63
product expression	0	8	21	10	3	0	1	1	0	6	9	0	59
readability	0	1	0	0	0	2	0	0	1	1	14	45	64
understandability	3	0	3	0	0	1	1	20	0	23	1	0	52
visibility	23	0	0	0	1	5	12	21	0	37	0	0	99
writability	1	0	0	0	0	1	1	38	4	26	0	7	78
TOTAL	151	51	207	38	55	19	68	207	20	334	54	115	1319

Figure 8. Attribute-dimension impact matrix

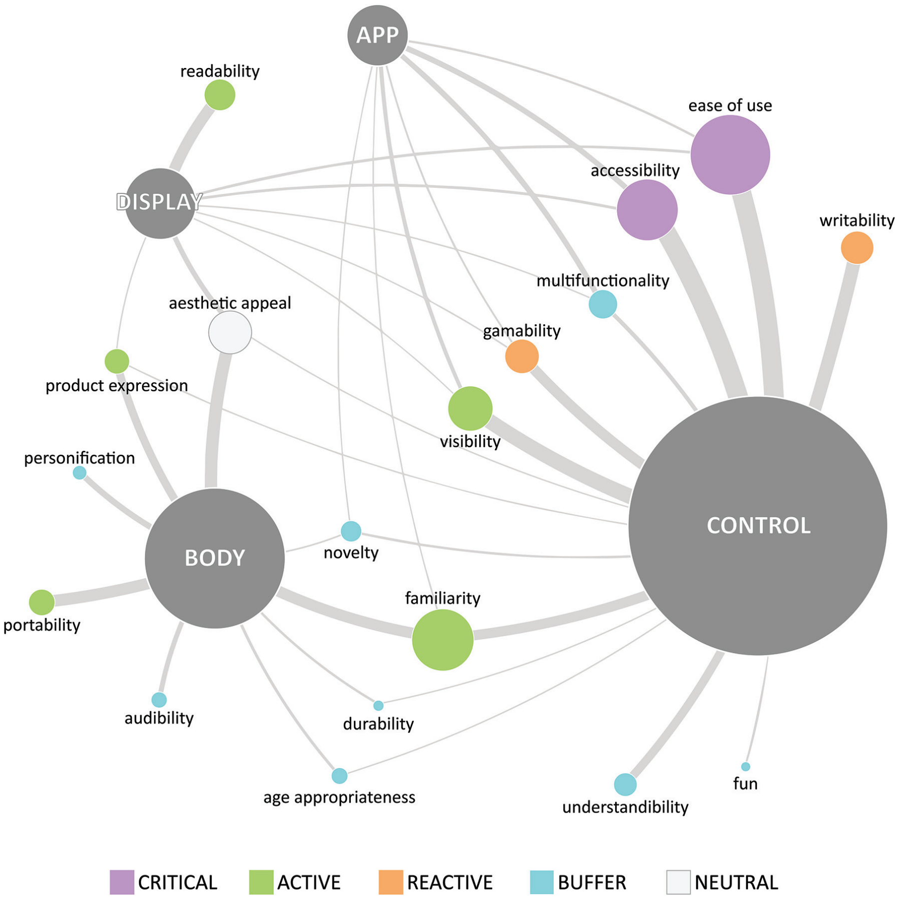

Figure 9. Attribute-dimension map (cut-off value=5)

product features are grouped under four main categories: applications, being the types of software embodied by the product; body attributes, being visual qualities such as form, color and size; control attributes, being features related to the use of controls, such as the layout and type of interaction; and display attributes, which are related to screen features such as size and color.

Attribute-dimension matrix represents both the total and individual impact of each product feature. To illustrate, perceived ease of use is affected significantly by the control features, while body-related features have almost no impact. Perceived novelty is associated with the types of available applications and the control type; while the hedonic dimensions, such as aesthetic appeal and product expression, stem from the body and screen-related features. In terms of total impact, body form, screen size, control type and applications are among the most influential product attributes.

Similar to the cross-impact analysis, the values in the matrix were exported to an attribute-dimension map in order to better visualize the hierarchies and connections (**Figure 9**), in which the circle diameters and link thicknesses reflect the relative impact presented in the matrix. Body, control and display (screen) components are grouped in the map, and although grouping the components resulted in data reduction, the map provides an overall understanding of how the participants related certain product components to dimensions of perceived product experience.

DISCUSSIONS

The gathered data is rich in terms of showing how perceived product features, i.e. a particular body shape or layout of controls available in the image cards, raise certain positive or negative reactions in user space, such as being valued or found irrelevant. An attempt was made to quantify the qualitative data to be presented as an overview at a conceptual level. Due to limited space, it is not possible to discuss every dimension and its relationship with specific product attributes. In this section, we try to highlight some of the findings in a brief discussion of design implications. The effects of the modified procedure, the limitations of the study and the potential areas for improvement will also be discussed.

Design Implications

It is no surprise that the children's mobile phones included in the study are designed from the point of view of adults, and represent the parents' needs and wishes rather than those of children. Some of the common design features include reduced function (i.e. texting and gaming), as well as parental control in creating a contact list and receiving calls. One other apparent design approach seems to be a child-friendly look in terms of form and the use of color, which was not always well-received by the participants:

> "[P1] looks like a toy. It is very small. Little kids would play with it, but not me." (Construct: looks like a phone – looks like a toy)

> "People would laugh at [P1] and [P2], they look like a bag. No one would laugh at [P5], because it looks like a real phone." (Construct: looks like a real phone – people would laugh at)

The cross-impact analysis shows that familiarity of the product expression, and personification are directly connected to the aesthetic appeal and age-appropriateness perceived by the participants. Children have an idea about what a phone should look like based on their previous experiences, and contrary to popular belief, children may not always favor "colorful" and "cute" products. This is especially the case for mobile phones, which are apparently products of desire, and are even perceived as a rite of passage from childhood to adulthood. In this case, product form is reflected in self-image, which may explain why the participants often found children's mobile phones to be "weird", "toy-like", "childish" and "for babies".

It is also evident in the cross-impact analysis that at the center of pragmatic concerns seems to be perceived ease of use and accessibility, both of which are in strong connection with control and display features. The dichotomy of physical keyboard versus touchscreen interaction seems to dominate this perception, along with the quantity and function of the keys available, and the screen size. Although none of the three children's mobile phones enable physical keyboard input for texting or dialing a number, it was interesting to observe that almost all participants assumed that they do, and judged the product attributes accordingly:

> "[P2] is the most difficult [to write on]. You push and push and push… There are so few numbers, how can you call your mom? There are many keys on [P4], and the letters are written on it. But not on the others." (Construct: easy to call someone – difficult to call someone)

> "[P4] has more keys. I would like to write something. Like I went somewhere, I ate ice cream… I can keep a secret diary." (Construct: You can keep a secret diary – you can't keep a secret diary)

Given the fact that children had no actual experience with children's mobile phones due to a lack of availability in the local market, these imagine attributes seem to stem from their somewhat limited experience with full-spectrum products. Dimensions such as writability, gamability and multifunctionality emerged through comparisons of the children's and adult's products, and these dimensions are associated significantly with concrete product attributes such as control type, number and layout, and display size, rather than abstract concepts such as software support. Similarly, the level and quality of volume (audibility) is mostly associated with the size of speakers rather than the underlying technology, while the need for the visibility of buttons or icons for accessing the phone's primary functions was frequently stressed by the participants:

> "[P5] has this square [menu] button, so it is easier [to find things] than [P1]. We first push the square and it [menu] is on, then we say 'mmm there is some stuff here'." (Construct: easy to find things – difficult to find things)

Such a tendency to draw causalities based on concrete stimuli may be due to the characteristics of concrete operational stage (Piaget, 2001), which explains how children attribute meaning to concrete product features, and how designers may benefit from it when mapping interfaces. The cross-impact analysis also shows that visibility is one of the most active dimensions in the system, with a high impact on accessibility and writability, and consequently, ease of use.

Although the intention in this study was to explore how children construe a particular product experience, the inferences drawn from the results should not be limited to the design of mobile phones, in that it is possible to transfer partially these cognitive structures to inform the designs of various other interactive products, such as game controllers, digital cameras and similar consumer electronics. This reusability of the findings stems from the strength of the method in relating tangible product attributes to abstract concepts.

Evaluation of the Modified Procedure

Our modifications to the typical RGT procedure included the use of dyadic elicitation, distributed elicitation and ranking. Aside from one participant, we experienced no problems among those taking part in following the construct elicitation and ranking procedures. Children were able to grasp easily the structured process, and sometimes took initiative in ranking, as well as elaborating on the constructs without being asked further questions. The distributed elicitation generated additional constructs in the ranking phase; but also resulted in repetitions, which sometimes caused boredom and distraction among the participants.

One significant difficulty was encountered in eliciting the construct poles. Most of the construct poles were expressed by simply adding "not" in front of the original construct, or describing the two poles as "easy to…/difficult to…". These difficulties in eliciting construct poles can be attributed to the fact that most original constructs are descriptive and have a direct reference to concrete attributes. Most of the time there was little need to ask the opposite, since it was too obvious, and for this reason we preferred to concentrate on the laddering procedure instead, and applied content analysis to identify patterns of meaning structures among the multiple user data.

Limitations and Future Work

One significant limitation of the study is related to the use of product images as elements. The lack of an equal amount of experience with each product resulted in limitations in the participants' comments, as well as reflections on imagined product attributes. Since we were concentrating on perceived attributes, we did not correct such misunderstandings during the interviews, but we observed that this limitation was reflected significantly in our results. As an example; although we know that control features are directly associated with writability and ease of use, we don't know what it means for children when such a feature is lacking.

The majority of comments were related to control and body features, while statements on software and display features were somewhat limited. This is a possible result of the selection of elements. The participants were unfamiliar with mobile phones designed for children, hence their comparisons were dominated by easily perceived visual attributes based on their past experiences. This may not necessarily mean that product form and controls are more important, but rather they are easier to retrieve from visual stimuli. Since this was an explorative study, we chose not to focus on a specific aspect of experience. When seeking a comprehensive understanding on a particular issue, such as the relationship between product expression and identity, it would be useful to utilize a range of products so as to reflect the diversity while keeping other features similar.

With reference to the user experience frameworks discussed earlier, another shortcoming of the study is in obtaining information on the usage context. Although the adopted methodology helped explore the user space in terms of subjective perceptions and backgrounds, it was not possible to investigate actual usage context. While contextual factors cannot always be controlled or foreseen, aspects of routine (i.e. typical school day) as well as extreme situations (i.e. moment of emergency) would provide valuable input for the design space. Integrating elicited cognitive models with ethnographic data, such as contextual observations, diary logs, and so on, may better inform designers on potential points for intervention.

CONCLUSION

Presented in this study is a systematic literature survey on the current trends in the role of children in design process, as well as a discussion of the benefits of early user involvement. Also presented is an explorative study and its design implications, as well as constraints of the methodology and potential areas for further improvement. It is not suggested that this methodology replaces existing user research traditions with children, but rather that it can inform and enrich the design space at earlier phases through user perceptions. Based on the findings of this study, we believe that a construct elicitation method based on RGT is a promising procedure for exploring the user experience from the perspective of children, with potential for further improvement. An integrative approach to data gathering, as well as feedback from designers on the utilization of the generated user information in the actual design process would help in the refinement of the method.

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EVALUATION OF CONSTRUCT ELICITATION AS A RESEARCH METHOD TO OBTAIN DESIGN-RELEVANT DATA FROM CHILDREN

Understanding user requirements and how users give meaning to their own experiences related to products is a significant input in the design of products that are acceptable to the target users. This issue becomes more important when designing for children due to our adult preconceptions about what they can and cannot do, and what they like or do not like. Although incorporating children's input into design process has been well-acknowledged in research practices, the dominant tendency is to involve children as testers of the designed solutions in later phases of the process. However, exploration of the aspects of user experience in earlier phases of design is crucial, allowing users to provide input into major design directions rather than merely into usability improvement. Another concern in user research is that designers may not always have the opportunity to come into contact with real users under the current market conditions, and in such cases, communicating a holistic understanding of the user space to designers can contribute significantly to the promotion of empathy with the end-users. Accordingly, there is a need to develop a research methodology by which design-relevant data can be garnered from children, permitting the drawing of a holistic picture of their product experiences while informing designers about user perspectives. This study makes two contributions to the existing body of work: (1) a systematic literature survey focused on current research trends regarding the level and impact of the input of children into design, discussing the significance of the early inclusion of end-users; and (2) an explorative study examining the potential of a construct elicitation method based on Repertory Grid Technique (RGT) with laddering procedure in eliciting design-relevant information from children. We conducted a study of the perceived qualities of mobile phones with 44 children utilizing a revised version of RGT as a tool to reveal subjective constructs of children to inform design process. The results show that RGT is a promising tool for the gathering of information from children, demonstrating the relationship between product attributes and attached meanings and modeling user-product interaction in a multidimensional and multi-layered manner.

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Anahtar Sözcükler: Çocuklar için tasarım, repertuvar çizelgesi tekniği, basamaklama, kullanıcı deneyiminin boyutları, kullanıcı modelleri

ÇOCUKLARDAN TASARIMA İLİŞKİN BİLGİ EDİNME YÖNTEMİ OLARAK YAPI ELDE ETME TEKNİĞİNİN DEĞERLENDİRİLMESİ

Kullanıcı gereksinimlerin ve kullanıcıların ürünlerle olan deneyimlerini anlamlandırma biçimlerinin kavranması, kabul edilebilir ürünler tasarlayabilmek için önemli bir girdi sağlamaktadır. Bu kavrayış çocukların neleri yapıp yapamayacakları, ya da nelerden hoşlanıp hoşlanmayacaklarına dair yetişkinler olarak sahip olduğumuz varsayımlar sebebiyle, çocuklarla tasarım araştırmasında oldukça kritiktir. Tasarım araştırmalarında çocukların katkısını tasarım süreciyle bütünleştirmek, literatürde önem verilen bir nokta olmakla birlikte, genel eğilim, çocukların sürecin son aşamalarına tasarım çözümlerini test eden rolüyle dahil edilmesi yönündedir. Fakat kullanıcıların, kullanılabilirlik iyileştirmelerinin ötesine geçerek ana tasarım kararlarına etki edecek katkılar sunabilmesi, ancak kullanıcı deneyimlerinin tasarım sürecinin erken aşamalarında araştırılmasıyla mümkündür. Kullanıcı araştırmalarına yönelik bir diğer kaygı da, günümüz koşullarında tasarımcıların her zaman son kullanıcılarla doğrudan temas halinde olamamasına yöneliktir. Böyle bir durumda, kullanıcı deneyiminin tasarımcılara bütüncül bir şekilde aktarılması, tasarımcıların kullanıcılarla empati kurulabilmesine önemli katkı sağlayacaktır. Dolayısıyla, çocukların kullanıcı deneyimlerini bütüncül bir biçimde betimleyecek bir araştırma yöntemi geliştirilmesinin önemi açıktır. Bu çalışma iki katkı sunmaktadır: (1) mevcut araştırma pratiklerinde çocukların tasarıma katkısının düzeyi ve etkisi üzerine eğilimleri inceleyen sistematik bir literatür araştırması ile son kullanıcıların sürece erken dahil edilmesinin tartışılması; (2) Repertuvar Çizelgesi Tekniği (RGT) ve basamaklama (laddering) tekniğini temel alan bir yapı elde etme yönteminin, çocuklardan tasarıma ilişkin bilgi edinmek konusundaki potansiyelinin araştırılmasıdır. RGT'yi temel alan bir yöntem kullanılarak, toplam 44 kullanıcı ile cep telefonlarının algılanan özellikleriyle ilgili bir alan çalışması gerçekleştirilmiş ve çocukların bu ürün deneyimine dair öznel yapılarının elde edilmesi hedeflenmiştir. Çalışmanın sonuçları, RGT'nin ürün özellikleri ve bunlarla ilişkilendirilen anlamlar ile kullanıcı-ürün etkileşiminin çok boyutlu ve çok katmanlı bir modelini ortaya çıkardığını, bu sebeple çocuklardan bilgi edinmek konusunda potansiyelli bir araç olduğunu göstermektedir.

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