Design with an eye for development

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Abstract
When designing with young children it is difficult to understand which participatory design method is best to choose. In this paper we argue that for choosing a good method both the design phase and the developmental stage of young children should be taken into account. We examine how three psychological theories can provide a basis for characterizing and selecting methods and conclude that Gardner's theory of Multiple Intelligences works best in the context of design methods.

Keywords
participatory design, young children, developmental psychology, co-creation methods

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces - Theory and Methods

Introduction
In designing with children the field's interest is moving from acquiring methodological knowledge in itself towards finding parameters to optimize design methods that involve children. Barendregt et al. [2] compared the effectiveness of usability evaluation methods on the basis of verbal skills of children, Bekker studied the quality of the output of design methods, depending on the engagement of the children in KidReporter [3]. Kelly et al. [6] developed Bluebells to optimize the relation between designers and children as co-designers. In her work, she stresses the importance of

a framework that describes the effectiveness of different methods and the context in which these methods are useful.

The effectiveness of different methods, we argue, is dependent on the developmental stage of young children. Their development is often taken into account in product development and in product marketing to successfully relate with the target user group. However, it is only rarely taken into account in a systematic manner when examining the suitability of design methods for children. In this paper we describe a framework to examine design methods based on children's various skills.

In designing with children, we have to take into account:

1. the children's capabilities to communicate, i.e.
    a. comprehension of instructions and
    b. expression of their contributions;
2. the children's capabilities in performing the task set by the design method; and
3. the children's capabilities with respect to the product domain.

Since the knowledge about product domain (3) is specific for the chosen design problem and not to the design method, this falls outside the scope of this paper. However, the children's capabilities in (1) and (2) are important to determine the potential success of using the design method with children. If children are not yet capable of communicating well, the instructions for the children need to be attuned to their needs. Similarly a method needs to be adjusted to the means of expression, and the tasks set.

Developmental psychology can provide general directions about what children are capable of when participating in design methods. In this paper we explore three psychological theories developed respectively by Piaget, Paivio and Gardner (as described in [1, 5]). Each theory is briefly discussed and then assessed on its relevance for optimizing design methods for young children.

Design and cognition

Piaget takes a cognitive approach towards the development of children. He distinguishes four phases in children younger than fifteen [8]; the sensori-motor stage (0-2), the pre-operational stage (2-6), the concrete operational stage (7-11) and the formal operational stage (11-15).

A Piagetian, or cognitive approach to design methods helps in understanding what the children can understand in terms of symbols and abstractions. A design task is symbolic in nature, for example the symbolic use of props to create a prototype or to mimic the usage of the actual product. This kind of behavior is possible from the concrete operational phase onwards. Abstractions are used to ask the children for their opinion on the product, for evaluations. Only in the formal operational stage, children are capable of the mental operations that are required to imagine and evaluate a product in its final stage.

This theory relates to the children's capabilities as to indications about the complexity of instructions that can be given to the children, or the complexity of the answers we can expect. Furthermore it relates to design tasks as to insights in the performance of children in logical reasoning, used for example with creating a why-why diagram, or a how-how diagram [7].

Designing however, does not only progress by symbolic, analytic and explicit activities, but also by creative activities in which many decisions and associations are

concrete, but implicitly made. Therefore the scope of this theory is too narrow for selecting design methods.

Design and (non) verbal intelligence

The theory of Paivio [1], distinguishes between a verbal (explicit) and non-verbal (implicit) intelligence and thus possibly has a better scope for our purposes than the theory by Piaget. Although his ideas are not described as a developmental theory per sé, his theory can certainly be applied to working with young children. Children have developed all the elements of their native language system by the time they are approximately six years of age. After that they develop their verbal skills in extending the complexity and length of their sentences [8]. The more a method relies on verbal skills, the more it is appropriate for older children.

As this theory clearly relates to the communicative skills of children, it also relates to tasks set by design methods in the sense that they rely on verbal and non-verbal skills. Verbal tasks reveal explicitly what children think (thinking aloud methods, co-discovery), non-verbal tasks (drawing, prototyping) result in implicit expressions revealing more than just words.

However, this theory is also close to one-dimensional. In fact, non-verbal design knowledge can be seen as a rest-category in which everything is captured that is not expressed verbally. Thus, further unraveling of the non-verbal intelligence is required. To have a richer scope of analysis, we explored the theory of Multiple Intelligences, that apart from verbal (linguistic) and cognition intelligence (logical intelligence), distinguishes six complementary intelligences.

Design and Multiple Intelligences

The theory of Multiple Intelligences [5] distinguishes eight different intelligences: (1) linguistic, (2) logical-mathematical, (3) musical, (4) visual-spatial, (5) bodily-kinesthetic, (6) interpersonal, (7) intra personal and (8) naturalistic. Currently, this theory is popular in education, and recently also in the field of design. At IDC2007 conference [4] there were five papers that refer to this theory to support their design decisions. However, as far as we are aware, nobody has applied this theory to a selection of appropriate design methods.

Gardner's theory provides a broad basis to compare design methods. If we look at children's explicit communication, linguistic skills are required, as well as interpersonal skills to interpret instructions and to communicate their verbal expressions in a comprehensible way. The design activities themselves can now be specified further according to what kind of intelligence is required to perform the design activity. Finally we can examine whether the required intelligences have been developed by the children. With such an analysis, we hope to predict which design activities are optimal for a certain age group.

Developing a framework for design methods

To develop a framework for characterizing design methods, we matched twenty-eight commonly used design methods (eg in [3,7]) with the intelligences. To confirm our observations we asked eight independent designers (with at least a university degree in industrial design or user system interaction) to give their interpretation of which intelligence(s) they would associate with a particular design method.

We provided descriptions of the methods and a definition of each intelligence. The result is a matrix (included in the appendix) giving an overview of which method is associated with which intelligence. The table shows the intelligences on the horizontal axis and the design methods on the vertical axis. As we did not ask the observers to distinguish between intelligences for

communicative and design tasks, the communicative intelligences were mentioned most frequently: the interpersonal and linguistic intelligence.

Experiments

Based on this framework, we generated hypotheses about the suitability of design methods for children. The hypotheses relate to the amount of information we can get from the children participating in a design session. The method that the children of a particular age group understand best and involves their strongest skills, should result in a better exploration of the design space than a method that suits the children least. To test this assumption, we designed a couple of experiments.

First we tested whether we could find a difference in a method that involves the least intelligences versus a method that involves most intelligences. If a method involves many intelligences, the children can use what suits them best, increasing the chance of success with this design method. The first positive results were presented at IDC 2007 [9].

The next experiment we propose is to compare the suitability of two design methods for two different age groups. For fifth-graders, the dominant intelligences are interpersonal and bodily kinesthetic, according to the matrix, acting-out (drama) would suit this age group best. This method could be compared to a method best suited for first graders, for which the dominant intelligences are spatial and logical-mathematical [10]. According to the matrix, a cognitive map would suit this age group best. A comparative study could show whether further use of the framework is justified.

Conclusion

To optimize design methods for children, we have developed a framework that provides a mapping between characteristics of design methods and skills of children. Based on our discussion of three different psychological theories we conclude that the Theory of Multiple Intelligences provides the most useful terminology to understand both the skills of children and the most common design methods. It provides a basis for experiments to compare and optimize design methods for children.

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Appendix

Design Methods vs Required Intelligences according to Gardner, as described in [5].

The highlighted cells depict that the intelligence is relevant for the design method. The last column shows the total number of intelligences to which the method appeals (# INTEL).

Method	Linguistic	Logical	BodilyKinesthetic	Spatial Visual	Interpersonal	Intrapersonal	#INTEL
2-D modelling				■			1
Articles	■						1
Descriptives	■						1
Drawing				■			1
FreeWordAssociation	■						1
NominalGroupTech	■						1
Photography				■			1
Questionnaires	■						1
Sittings	■						1
Storytelling	■						1
Workshops	■						1
3-D modelling			■	■			2
Brainstorming	■				■		2
Cognitive Map		■		■			2
Collage				■		■	2
Games	■				■		2
How-How	■	■					2
Interviews	■				■		2
Language	■				■		2
Mission Mars	■				■		2
On-line illustr	■			■			2
Scenario disc.	■				■		2
SocialDiagramDrawing				■	■		2
Ideal Solution	■				■		2
Dramas	■		■		■		3
Simulation and	■		■		■		3
Prototyping	■		■	■	■		4