

Teaching Interaction Design and Children: Understanding the Relevance of Theory for Design.

Tilde Bekker¹, Wolmet Barendregt²
Panos Markopoulos¹, Janet Read³

¹ Faculty of Industrial Design, Eindhoven University of Technology, Den Dolech 2, 5612 AZ Eindhoven, The Netherlands, m.m.bekker@tue.nl, p.markopoulos@tue.nl

² Department of Applied IT, University of Gothenburg, Forskningsgången 1, 412 96 Gothenburg, Sweden, wolmet.barendregt@ait.gu.se

³ School of Computing, Engineering and Physical Science, UCLan, Preston, UK, jcread@uclan.ac.uk

Abstract. In this paper we address the challenge of teaching interaction design for children's products especially pertaining to bridging the gap between child development theories and interaction design issues. We describe our experiences from developing a one-week course on interaction design and children, that is part of a competency based Masters program in design. We conclude that key elements in this course, to support learning how to incorporate theoretical knowledge in design, are a) providing design tool that covers a child developmental model of four domains (cognitive, social, emotional and physical) , such as the Developmentally Situated Design cards for creating child personas and design concepts b) using a design exercise c) giving students the possibility to work on several iterations d) giving students more than one age-group to work with in the project, and e) providing the students with an evaluation protocol.

Keywords: Design education, child development, theoretical knowledge

1 Introduction

'Know thy user' is an often cited maxim that captures the core philosophies of Human Computer Interaction (HCI) and user centered design (UCD) approaches. HCI and interaction design textbooks provide a range of methods and tools to help designers identify the needs, capabilities and preferences of their eventual users in order to make informed choices during design. However, despite the commitment to understanding users such methods, tools, and principles remain agnostic towards different users. The general principles for good user interface design, e.g., [1], or methods for inquiry and testing are proposed as generically applicable to all users. This generality is a major strength of UCD methodology, but also a core weakness. The field of Child Computer Interaction (CCI) has arisen out of the need to develop methods, tools, and design knowledge that are specific to children and therefore more informative to designers.

Children and adults differ in many ways, but with regards to interaction design there are three key aspects characterizing these differences: children do different activities with interactive technologies than adults do, they behave and think differently, and they have different concerns about such technologies [2]. Furthermore, the abilities and skills of children change as they age and develop, making it an especially challenging task for students to get a grasp of this target group. Although having access to children during taught courses on CCI would be very insightful, this is not always possible. Therefore, Eriksson and Torgersson [3] point out there are many different aspects that should be covered in a successful course on CCI. They refer to the eight critical topics suggested by Gilutz et al. [4] (Communication, Psychology, HCI, Children's HCI, Pedagogies, Technologies, Experiences, Design) and state that there are differences between undergraduate and postgraduate courses as suggested by Read [5]. In our experience, undergraduate students often indicate that they find the Psychology topic rather difficult and are in need of design approaches that are based on theoretical knowledge about children's developmental stages, ages and abilities and which can be used throughout the design process [7].

In this paper we discuss the progressive development of an interaction design course to give students an entrance to child development theories in a design context. The course focuses mostly on the aspects Psychology, Experiences and Design as described by Gilutz et al. [4]. We give a short overview of the first years of the course and then proceed with a deeper discussion of the changes made during subsequent years identifying how these changes have affected students' ability to integrate theoretical perspectives in their design work.

2 Child Development Theories and Interaction Design for Children

Child development theories, theories regarding children's learning, social development, or socialization as consumers, and other theoretical perspectives can provide useful frameworks for discussing child computer interaction or to inform interaction design choices. At least this ambition has been a long standing goal for the field of child computer interaction; for example, the early and seminal work of Papert was founded upon Piagetian psychology, e.g., see [8]. Methodological discussions on usability testing with children typically rely on considerations of the cognitive and social development of children as test participants, e.g. see [9]. Discussions on different interaction styles, e.g. pointing techniques and menus, has similarly been rationalized on the basis of well-established views regarding children's development [10].

Despite their prevalence, these attempts have so far not succeeded in making the link between child development theory and interaction design explicit and operational. There have been a few attempts to do so in the past. For example, Antle [11] discussed how child personas could help inform design for an industrial development team that did not have specialized expertise and did not have the resources for involving children in their design process. These personas were partially based upon knowledge gleaned from child development theories. A substantial effort

to derive guidelines based on child development literature was reported by Gelderblom and Kotzé [12]; apart from their originators there is little experience with applying these guidelines, so it is not clear whether they succeed to inform design; in any case though, long lists of guidelines are known to be hard to apply in practice as they capture few of the choices facing an interaction designer and often provide conflicting recommendations [13]. Arguably, educating interaction designers to make developmentally appropriate choices for children is a necessary step towards successful interaction design for child users.

Such an education is not free of problems though, especially as what is at question is not the designers' knowledge of a particular theory, but their competence in applying theoretical works to the design problem at hand. Books and courses, the traditional modus of acquiring such knowledge, seem not to be sufficiently actionable in the context of design (see also [5] and [4]). This difficulty in making theoretical knowledge from social sciences easily applicable in design is not unique to the design of children's products, and several design researchers have proposed related solutions for other domains. For example, Lucero and Arrasvuori [14] developed their PLEX Cards to communicate a framework about designing for playfulness. Lockton et al. [15] have created the Design with Intent method to guide design teams on how to design for influencing user behavior and recently, Bekker and Antle developed the Developmentally Situated Design (DSD) card tool to provide a hands-on tool that presents child development concepts and their relation to design [7]. In this DSD tool, each card mentions a few key points regarding the cognitive, physical, social, and emotional abilities of children in a specific age group. Designers can use the cards as reminders or engage in playful activities that allow them to draw relations between groups, make comparisons and generally make easily accessible, and keep salient during design, children's abilities and interests and how they develop with growing up (see Figure 1). Similar to Eriksson and Torgersson [3], we decided to incorporate the DSD cards in the course to provide an easy compilation of child development knowledge for designers.



Fig. 1: Example card (front and back) DSD cards.

In the remainder of this paper we describe and discuss how we have developed a course to teach Industrial Design students how to apply child development theory to interaction design for children's products, systems, and services. The early years of the course are first described and then we discuss the progressive changes and improvements that have been made in order to come to the current setup. We also discuss what other teachers of similar courses can learn from our experiences.

3 Teaching an Interaction Design and Children Course

3.1 Context of the Course

This curriculum of which this course is a part is a Masters' level program in interaction design, which follows a competency-centered learning approach. This means that rather than the traditional focus on learning knowledge and skills in a simplified, idealized and compartmentalised form, the emphasis is on allowing students to develop holistically their overall competency as interaction designers in the context of design assignments of realistic complexity. Learning is self-directed but is supported by a collection of elective short courses providing them opportunities for competency development along more constrained directions. Such courses typically last one or two weeks. Students construct their own self-development plan which combines projects, modules and extra-curricular learning activities. Competence is understood here as an individual's ability to select, acquire and use the knowledge, skills and attitudes that are required for effective performance of the design profession in a realistic design context. A key premise of this approach is that design competency develops in context as a whole, pertaining to the designer's ability to creatively and flexibly deal with the large amounts of constantly evolving information relevant for their profession.

3.2 Learning Goals

The course that is the focus of this paper is one of the optional courses¹ available to students on this Masters programme and is entitled 'Interaction Design and Children (IDC)'. Given the competency based approach to education, the priority in designing this course was not to deliver an in depth understanding or accurate memorization of different child-development theories but was to show the relevance of different theories to daily activities and to interaction design concerns.

The following learning goals were set by the instructors of the course, which were communicated to students at registration time and repeated at the outset of the course:

1. Students should be able to explain, and discuss about, the different schools of thought in developmental psychology in relation to their design work.
2. Students should be able to apply elements from child development psychology in the design process. Specifically, they should be able to locate and apply child development knowledge about two different age groups and demonstrate how these differences are reflected in the design.

¹ Note that courses in this program are usually called modules

3. Students could be able to plan and carry out design activities involving children in the development of new concepts or the evaluation of existing products, demonstrating awareness of relevant developmental issues and making deliberate and informed choices linked to hands on knowledge acquired through projects.

In this paper we focus mainly on an assessment of the extent to which the second learning goal was met by considering the effects of changes that were made to the course to help students reach this goal.

3.3 General Setup of the Course

The three main topics covered in the one-week course are: child development, design and evaluation methods, and diverse applications. The mode of delivery is varied, including motivational/introductory lectures, reading assignments and a hands-on practical design assignment. During the course students typically receive introduction lectures to child development topics, IDC design methods, and IDC evaluation methods. They are asked to apply this knowledge to the design case assignment (see Table 1).

Table 1. Overview of the (final) IDC course schedule: while the overall setup in terms of lectures was fairly similar over the years, the exercises for the student teams have changed.

Day	Lecturer	Student teams
1	Introduction lecture on child development theories.	Create initial concepts and persona skeletons
2	Lecture on various design methods Lecture on forms of play (as of 2011)	Present initial concepts and persona skeletons
3	Introduction reading assignment on diverse applications for children	Present concepts and personas Reading assignment about influential design within IDC, to reflect on quality design rationale
4	Lecture on methods for evaluation children's technologies	Evaluate concepts using a form of expert review
5		Presenting the designs and the design and evaluation process.

4 Theoretical Application In Design Study

We have taught the IDC course on an almost yearly basis between 2008 and 2014, and the set-up of the course has evolved over time. This paper describes all years of the course but focuses most deeply on our experiences during the most recent iterations of the course, where the DSD cards were introduced. To examine how the changes made in the course, over time, supported the students in considering child developmental issues during the design and evaluation process, we conducted an analysis of the presentations and the reports that the student teams generated over the

most recent years. From a learning perspective it is important that students consider the opportunities of the diverse child development topics. Thus we hope to find many references to diverse categories in their design rationale and other descriptions, either in why they incorporated it in their design or why not. Note however that the emphasis of the course is on improving the student's design process eventually resulting in better future designs, not on creating a perfect design during the course. Explaining this to the students makes them less hesitant to examine the relationship between skills and abilities of children and design decisions, for example by oversimplifying or making things overly complex. This helps them to learn about how to design for different skills and abilities.

We start by describing the iterations of the course and then explore how the students incorporated theoretical knowledge in the creation of one or more persona skeletons and in a final persona in explaining the design rationale of their concepts and in the evaluation of the concepts.

5 Results

5.1 The first year: Literature in the form of chapters

In the first run of the course (2008), we provided students with literature on child development in the form of four chapters from a life span development book [16], covering the four developmental domains of cognitive, physical, social and emotional development and two chapters from a book on marketing products for children [17]. The overall setup of the course worked well but the main drawback was that students had difficulty gathering relevant information from the literature resources to incorporate into their persona descriptions. They did apply a persona to an evaluation activity, but not to a design activity. Furthermore, learning how to apply theory in a design process was inefficient, because the relationship between the three activities was less clear: the students made a persona skeleton without having a design case in mind, then they developed a focus group setup for a context of persuading children to finish their meal and the evaluation was done of a website.

This complexity was exemplified in a quote from a student who participated the first time the course was taught:

"Finding a way to structure the development aspects was hard. We realized that everything is connected (physical, cognitive, social, etc.) and putting the aspects in a perfect framework would not be realizable in such a short time."

5.1 The second year: Introduction of the DSD cards and a design exercise

The main changes from the 2008 to 2010 version of the course were the introduction of the DSD cards and the inclusion of a design exercise. As part of the lecture on child development students were introduced to the DSD card tool, which is a hands-on design tool that can provide design students and designers with insights in child development [7].

The card set describes theoretical constructs for three different age groups: 5-6, 7-9 and 10-12 year olds addressing the following domains:

- Cognitive: e.g. reading, information processing and working memory.
- Emotional: e.g., motion expression, emotion regulation, emotion understanding.
- Social: self-esteem, perspective taking, friendships.
- Physical: locomotion, manipulation (gross), manipulation (fine) and stability.

The purpose of the DSD cards is to sensitize students to the wealth of knowledge available in child development literature by giving them access to a limited set of constructs that are assumed to be applicable to a wide variety of design problems. Furthermore, the DSD cards provide a short explanation of the concept (e.g. on the left hand side of Figure 1, and two scenarios about children's daily lives in which this construct can play a role (e.g. the picture in the right side of Figure 1). The scenarios provide a bridge between a fairly abstract concept and its relevance to children's activities.

We also added a design exercise so that students explored the design relevance of the knowledge embedded in the DSD tool for two age groups. For each age group chosen, the students had to explain the main design rationale for design decisions and make explicit the various aspects of children's skills, abilities and interests in relation to context of their design cases. This second run of the course gave rise to more in-depth reflections by the students as illustrated in the following quote:

"One of the things I liked very much about this module was the child development card-tool. I noticed that this was a very quick and easy way to get a first overview of what children of a specific age can or can't do."

There was some evidence that students were thinking beyond the immediate use of the DSD tools with, for example, one applying it almost in evaluation:

"When I generated new ideas, I used the tool to validate if the idea would be appropriate for the age of the children. This worked well because this way I was able to position the more complex idea that required more skills to the older age group."

In rationalizing their design decisions, the students considered skills from different domains (e.g. cognitive and emotional) in their reasoning about their design ideas although this tended to be quite superficial – possibly as they only had the one activity to perform (see Figure 2). For example, they only reasoned about high level design decisions, to focus on group activities for the older age group of 10 to 12. Furthermore, because they did not make personas the students did not develop an understanding of how the development of different skills can be related to each other.

ColourFlare redesign ideas (ages 4-6)**Bouncing ball**

Children of this age are still working on skills like throwing, catching and running. Since they are so young, the current flare-shapes design will probably be too breakable. We suggest changing the shape of the flares to a ball that bounces. You could then for instance make the ball change color by bouncing it against the floor. Also the overall shape should be smaller for their little hands.

Another added bonus could be adding sound, because children of this age often like funny sound like a “boing” when it bounces.

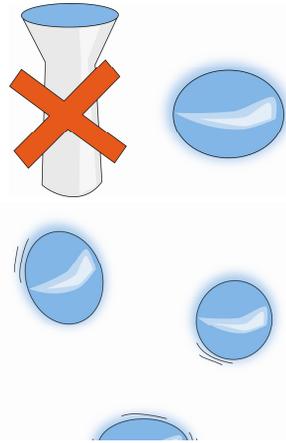


Fig. 2: An example (re-)design exploration using the DSD cards.

5.1 The third year: Extra iteration in persona design and expert review

The three main changes from 2010 to 2011 were to add an extra iteration in design and persona creation, have the students conduct expert reviews of their own design instead of writing only an evaluation plan as had been the case originally, and work on the same design case throughout the course. The extra iteration in the design process and the expert evaluation was intended to provide multiple points for discussion and reflection on applying theory to design with the aim to add depth to students' understanding. Below we shortly describe our judgment of the students' work regarding their personas, their design rationale and their evaluation.

The personas of all teams contained at least three of the child development domains, and usually both general topics and concrete activities. Most teams explicitly referred to the DSD cards when describing the various characteristics. One team mentioned aspects of each domain but didn't mention the DSD cards explicitly. Some teams started with a skeleton with more general characteristics, as presented by the front of the DSD cards, and then refined this in the full persona by translating from abstract to concrete activities, using examples similar to those given on the back of each card. Other teams focused directly on concrete activities, even in their skeleton descriptions. All teams made explicit how their designs were age appropriate, with some also mentioning the differences between the designs. Most teams used at least three domains in their design rationale. However, one of the teams followed a slightly different approach using a single domain (emotional development) as the main inspiration for their design.

One student described how he experienced the role of the persona creation process (see also Figure 3): *“In making the personas for this module, many bits and pieces of knowledge could come together; my previous experience, my assumptions about designing for children, facts about child development, existing toys, etc. [...] As I described earlier, persona making as a design activity has the potential to link fragments of knowledge and combine them into a form that embodies my*

understanding of the user. Persona making thus is an activity that lies in between the framework and design worlds and can therefore act as a link in the design process.”

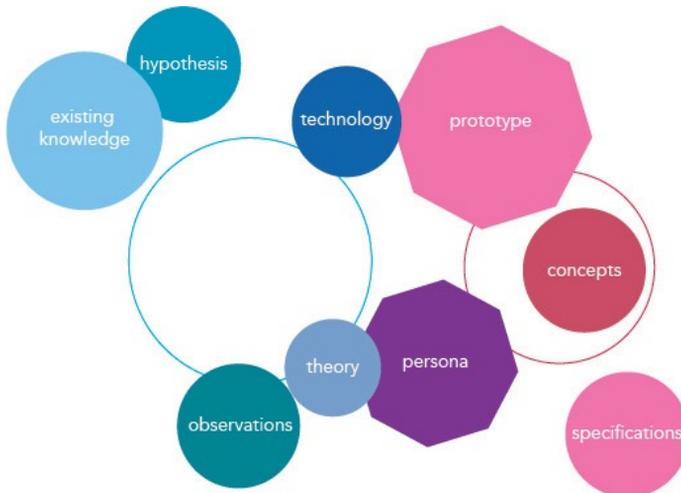


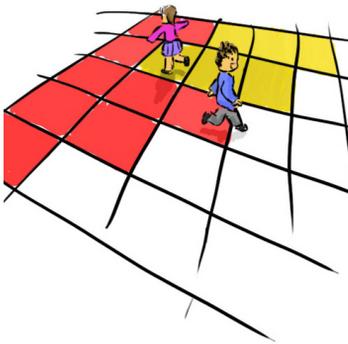
Fig. 3: How a student describes his new understanding of the role of persona creation (purple) to bridge between input (research in blue) and output (design related in pink and red) activities.

The teams seemed to struggle somewhat with the evaluation in terms of how/whether to relate it to the DSD cards. Some of the teams explicitly tried to adapt the SEEM method [18] to the DSD cards and mentioned that this was hard since SEEM was meant for single-player computer games rather than for multiplayer (open-ended) games or toys.

One student explained how using SEEM helped to evaluate their design: *“Using the SEEM method and changing it towards a method that was effective for real life games instead of screen based games gave me insight in how to analyze the step by step process of interaction with a product from a child’s point of view but without the actual need of a child.”*

During evaluation some students excluded a domain in their expert evaluation because this domain had not been designed for. Others asked help from an expert in design or an elementary school teacher. In their reflections many students indicated that it still would be useful to have access to children for the evaluation.

There was evidence of students seeing the potential for the DSD cards with one commenting that the cards could be improved: *“Especially cognitive cards that deal with imagination, pretending and fantasy would have been welcome”* and one student was able to reflect on the transformative value of the course on his thinking writing: *“But to think that how or what they play will be exactly the same is naive. Times change, and so do children’s interests and frames of references. [...] I can take my values of childhood play, learn about child development, a child’s context, abilities and preferences and combine all these aspects into a synergetic iterative design process.”*



WHY IT WORKS FOR THIS AGE GROUP

Based on our persona and the data underlying the persona:

Cooperative play is not needed to make the game fun. At this age the children often play alone, or in a small group, but not necessarily cooperatively. Why: because of a change in **perspective taking**. At this age friendship means: the sharing of toys, and friends are convenient playmates – not team members.

The game naturally adjusts difficulty to the abilities of the child. More advanced features will only present themselves when the child is able to trigger them, mostly determined by their **analytical ability**. For starters, the simple action-reaction play is already an engaging interaction .

- The **physical elements** of this game or of an explorative nature. The child is allowed and encouraged to try out **different ways of activating the tiles**, and the game does not impose some sort of limitation, like; you have to stand still for x minutes.

Fig. 2 Examples design: Magic Tiles (for 4-6 years) allow children to create colourful patterns in a grid (left) and part of the design rationale (right)

One student commented on the possibilities provided by the four domains as well as the connection to evaluation writing: *“In the module we were introduced to a model of child development based on four domains: cognitive, physical, social, and emotional. This model also proved to adapt itself smoothly to the evaluation and validation of the actual concepts that were created. [...] It seemed to me that the concepts that touched upon all four domains were the most interesting.”* Another reflected on how he had been made more aware of the differences in age groups: *“The DSD cards incorporate a lot of facts for different age groups, including physical, social and cognitive characteristics. It functioned for me as inspirational and validation source. It provided me and the group a common ground to begin from.”*

The introduction of the DSD cards thus seemed a useful adaptation, providing students with theoretical knowledge about both domains and age groups.

5.1 The fourth and fifth year: Providing an evaluation protocol, and explaining different forms of play.

During the third year it became quite obvious that the assignment for the evaluation activity needed improvement. Some student teams were very creative in combining an expert evaluation method with reflecting on the four domains of skills and abilities of children. However, because no formal protocol was provided for incorporating this in the evaluation activity, in most cases linking the four domains to the evaluation was done in unsystematic manner.

Because students had mentioned in previous years that information about play was missing, a lecture about different forms of play (e.g. constructive, fantasy and social

play) was added to the course. Furthermore, in the fifth year we were able to arrange input from a domain expert, related to the design case (a physical exercise teacher): on day two and on day four of the course.

Below we describe some insights related to the main changes in how the course was set up.

In the design iterations students were able to look into the relevance of the theoretical knowledge multiple times, and thus apply the knowledge also to more detailed design decisions. For example, one team explicitly used the designer tips (or questions, see Figure 1, left figure) on the DSD cards as a design reflection tool for developing their designs further (see Figure 5).



Can the design help a child recognize when they are close to completing a task?

The design gives feedback on when a task is close to completion by showing that the bar is being restored to fill by the blocks. It also communicates when a certain task is becoming more important, as the PU is running out of a certain health bar

Fig. 5 This design called Care Cubes (age 4-6), entices children to collect coloured blocks to take care of the big object, and fill the coloured health bars on the top (left) and reflection designer tip on DSD card (right)

Overall, providing the students with ideas about doing expert reviews and user tests improved the evaluation approaches they took. They were seen to be more aware of including multiple perspectives in their evaluation focus, for example examining both multiple perspectives as mentioned in the DSD cards, and sometimes (if relevant), also including topics related to different forms of play. See figure 6, for a design of a student team that explored different scenarios inspired by pretend play and constructive play.

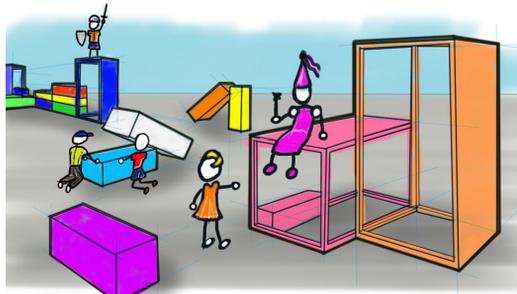


Fig. 6 Example design that was described with a **constructive** play scenario and a **pretend** play scenario

The main challenge of the course is to have students make the effort of arranging children participants for an evaluation. The more pro-active students are able to arrange this, whereas other students more quickly go for the, possibly easier, expert review approach. However, also in the expert review approach, they often take a more structured approach, for example by taking the designer tips (or questions) on the DSD cards as an inspiration source for framing evaluation questions. By covering different complementary approaches of gathering knowledge about children, students develop diverse skills in doing this. One student describes her opinion as follows:

“Through the theory presented in the module and the DSD cards my fellow student and me were able to gain feeling with both age groups.. we decided early on in the module to arrange a session to get acquainted with children of this age group. [...] Complementary to the theories used, interacting with the focus group helped me to create a more complete image for the specific age group. In my current project I would therefore also like to choose a specific age group early on in my project and explore that group more in depth by for example creating multiple persona’s and by interacting with them.”

Having the opportunity to talk to a domain expert also provided students with more opportunities for combining more abstract theoretical concepts with, for example, how this would translate to activities in a specific context, such as a gym class: *“The gym teacher were mostly used to get insight into the activities that are done during a lesson and how the children act to that. Also, they provided insight into how they address specific domains such as physical and cognitive during a lesson and how they combine them.”* One team used the questions on the DSD cards as pointers for analysing video data of other students who enacted children using their low-fi prototypes. They analysed the video to answer the questions described on some of the DSD cards: *“We conclude that our strategy (analyzing the DSD-cards into depth and using it as main inspiration for our experiment) worked out in terms of age appropriate design. For now we can say that it led to knowledge which we probably wouldn’t have gained without using our strategy. The DSD-cards led to age-specific questions for our experiment participants, and unexpected results and conclusions are found by experimenting with users.”*

6 Discussion

We have presented the results of several years of adapting and improving a course on how to design for children, focusing particularly on the incorporation of child development theories. Our interest was not related to the extent and accuracy of the students’ knowledge of these theories, but focused specifically on their ability and attitude towards applying elements of these theories during the design process. We cannot and do not make claims regarding the level of expertise the students have in child development theories as such.

To a large extent we have looked for evidence of student’s competency development in the reflections they provided themselves. As such, one may wonder if the narrative provided is indeed an accurate representation of events and whether this narrative is solely created to evidence a competency development, rather than being a

self-presentation on behalf of the student. Clearly this danger exists, and is inherent in the educational approach. However, it is exactly the role of staff during the many moments of feedback and evaluation, to evaluate such narratives, relate them to evidence and provide appropriate feedback. Typically, students are not evaluated just for the statements made about their competency development, but about the quality of their reasoning and reflections. As such we are fairly confident regarding the conclusions from this analysis.

The contribution of our paper consists, among other things, of the list of elements to support the students learning and adoption of theory. Although some of the items in the list seem obvious, the challenge lies in optimising the iterations and the detailed activities in the design process for the process of the course. How this turns out for other educators would depend on their educational context, e.g. students prior knowledge etc. Furthermore, especially having students make explicit the link between theory on the one hand and elements in the personas and the design rationale is crucial in their own understanding and the possibility for the instructors to facilitate the learning process.

The course was given during one week to industrial design students who are in their fourth year of study. As also explained in [5], the context of the course, including student needs, instructors' area of interest and amount of time (and other resources) influenced the choices made. It is of course an open question whether these experiences we reported could generalize to other groups of students, with different schemas and constraints.

Of the eight suggested topics critical to teaching IDC mentioned in [4], we combine Psychology, HCI, Design and Experiences. Using the time to go through iterations in design. For different students the emphasis might be different, e.g. less design oriented, but more theoretical, including aspects such as Pedagogies and Communication topics.

Variations of the setup have been used in different contexts for students with similar learning goals. For example, the DSD cards have been used in a two-hour workshop with Masters students in another Interaction Design program. In this workshop the students only designed one concept for one age group without iterations, which resulted in designs that were not yet fully grounded in the theoretical knowledge provided by the cards. Students also seemed to struggle with the difference between age groups since they had only worked with one specific age group without being able to compare this group with the older and younger age groups. However, they did make a first start in reasoning about children's skills and abilities and were often wondering about things like 'do children of 7 to 9 years old know the difference between left and right?' So, while individual components of our approach may be valuable in themselves, we do think that the strength lies in the thorough combination of exercises and tools.

This limitation is inherent in all action research, which has the dual purpose of the action goal (here improving the learning of the student) and the research agenda (learning about the educational process), so a disclaimer for undue generalization suffices.

7 Conclusion

We have described the evolution of a course for teaching Industrial Design students how to apply constructs from child development theory.

Overall students were more and more able to apply theoretical constructs in the various design activities during the course, both in idea generation and persona creation. In the last course round they included constructs from the four domains of social, emotion, cognitive and physical development. Furthermore, students were mostly able to translate these constructs to relevant children's activities. This means that the course set-up sensitized them to child development knowledge. They were also fairly well able to reflect on the differences between abilities of the two age groups for whom they had to design. This means that the approach helped them reflect on age-appropriate design decisions.

Based on our experiences of improving this course over several years we consider the following elements crucial for helping students to incorporate theoretical knowledge:

- Let students do a design exercise, which includes creating skeletons and personas for two different age groups to help them experience how to apply theoretical knowledge to making age appropriate design decisions.
- Let students use a pragmatic tool, such as the DSD cards, to inspire and inform design decisions from the four different theoretical perspectives (social, physical, cognitive and emotional domain)
- Let students do multiple design iterations, to have an opportunity to provide feedback about the proper interpretation of the design knowledge applied, and about other opportunities for applying theoretical knowledge. This gives them experience in applying theoretical knowledge to different types of design decisions (e.g. more global decisions early in the process, and more detailed decisions later in the design process).
- Arrange access to a domain expert, that can complement the theoretical knowledge with knowledge about skills and abilities specific to the topic of the design case.
- Provide students with an evaluation protocol, so they go through the evaluation process in a structured manner, incorporating multiple perspectives in their evaluation questions.

Since designers, even experienced ones, may sometimes have to acquire new knowledge about certain user groups that they have not targeted before, we suggest that a similar setup may be a suitable way to sensitize them to relevant literature, as well.

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