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Design Thinking: An Educational Model towards Creative Confidence

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Abstract. Design creativity is one of the most relevant fields in design and innovation. To better understand the effectiveness and origin of it, this study draws attention to the question of how design creativity can be mediated via design education. Since institutes exist that focus on teaching design thinking, the question arises what the experts of education believe they achieve with their lessons and how they support students in developing a capability of thinking and acting creative. In the empirical part of this study we find that there are different levels of creative knowledge, skills and mindsets that can be achieved by design thinking education, culminating in a capability that is called 'creative confidence'. Building on these results we demonstrate how design education contributes to both the development and understanding of design creativity. Furthermore we suggest a definition of "design thinking" as a learning model towards creative confidence.

Keywords: design thinking, education, creative confidence, creative competence, creativity, d.school, modes, mindsets.

1 Introduction

Design creativity requires various techniques, methods and conditions. Studies have claimed the importance of the external setting (von Thienen et al. 2010), team communication (Leenders et al. 2003), non-routiness, unstable environments and incompleteness of operational specifications (Pasmore 1997) for increased collaborative creativity. These parameters focus on the requirements of the working space and team atmosphere. Since many authors view creativity and innovation mainly as an information processing activity (DeMeyer 1985; Moenaert et al. 2000), one of the core products of design creativity is the generation and reweaving of knowledge (Leenders et al. 2003).

This knowledge assembles in the field of design education. Professional teachers have to pass on their certain knowledge about crucial fundamentals of design creativity to the students. In order to provide this specific knowledge, various pedagogical concepts like project-based learning (PBL) and the systematic teaching of tools, mindsets and skills have been developed.

Design education is the base of knowledge about design creativity. Therefore, understanding the ways design creativity is taught will lead to a better understanding of the human capability of solving complex problems and creating "a valuable, useful new product, service, idea, procedure, or process by individuals working together in a complex social system" (definition of "creativity" by Woodman 1993). Finding out more about the nature and potentials of design creativity thus implies the evaluation of the education in creative design.

Enabling creativity via design education still lacks a broader exploration. Much effort has been placed on evaluating the way students learn via PBL and how they develop their design intuition (e.g. Brereton 1999, Yang 2003, Adams 2003) or on developing "student-centered learning by design" for middle-schools (Kolodner 2003) and specific curricula in universities (Kjersdam 1994, Luxhol 1996). However, fewer studies reflect the actual educational methods which are used by teachers in design institutions to foster creativity.

In this study we will analyze a specific model of design education that conveys design creativity. We will therefore focus on design thinking as a meta-disciplinary concept and education model.

For that purpose experts of teaching design creativity in the USA and Germany have been consulted. We conducted a case study in cooperation with two design education institutions, the *d.school* in Stanford, USA and the *d.school* in Potsdam, Germany. In our interviews, the teaching experts were asked to describe goals in education as well as methods in teaching design thinking.

Both schools are multidisciplinary institutes of design thinking with Master's and Ph.D. level students from various faculties (such as engineering, business, medicine, law, humanities and sciences, education and earth sciences). As little is known about the formal education of these design thinking institutes, we see

our study as a first step towards a better understanding of how design education and design creativity work. Furthermore, our insights will offer an alternative definition of design thinking within the educational context.

This paper is structured into five sections. In the second chapter we will give a short introduction on design thinking in general and especially on design thinking education. The third part describes the method and procedure of our research. In the fourth chapter we present the empirical results that were generated from semi-structured interviews with d.school-teachers in Stanford and Potsdam. The fifth chapter discusses the implications of our research and explains how skills and tools can be used to foster a creative way of developing solutions to complex problems.

2 Design Thinking Education

Evaluating design thinking education helps to understand relevant parameters of design knowledge and design creativity.

To better grasp the role and the goals of design education, interviews have been conducted in institutes that are specialized on educating design thinking. In this section we will therefore give a short overview about the crucial terms by enlightening the models of design thinking and design thinking education.

2.1 Design Thinking

Design thinking is a holistic concept to design cognition and design learning that enables students to work successfully in multi-disciplinary teams and enact positive, design-led change in the world. As a problem solving approach that has been tried and tested with socially ambiguous problem settings, it deals with everyday-life-problems, which are nonetheless difficult to solve – "wicked problems", as Horst Rittel (1972) termed it. Hence, design intends to offer a concrete solution to a complex problem that is socially ambiguous and neither easy nor certain to comprehend. Design thinking focuses on this need to create ideas and find solutions (products, services, systems) for wicked problems – solutions, which are viable and novel for the particular groups of users (Lindberg et al. 2010).

Furthermore, design thinking can be seen as a meta-disciplinary concept which "turns out to deliver a precious methodology for interdisciplinary creative work as it specifically complements mono-disciplinary thinking" (Lindberg et al. 2009).

In contrast to analytical thinking in science, which leads to a mono-disciplinary, purely technical and solution oriented way of solving problems, the taught strategies focus on multi-disciplinary teams and the involvement of all perspectives – they are called design thinking (Brown 2008; 2009; Dunne & Martin 2006; Lindberg et al 2009).

The explanations of the interviewed teachers varied when they were asked about their personal definition of design thinking. This fact also reflects the multiple definitions that occur in the research literature about design thinking. We will discuss this later on. Initially, we want to adopt the following definition of design thinking in our study:

> *It is not a static process, but an approach to creative problem solving. Each team and individual develops their own process as they work on a problem, adapting and adding to it as they go. The key element is being mindful of how you work, not just what your outcome is. Regardless of the steps you take, the elements underlying the process are the mindsets of empathy, an attitude of prototyping, collaboration, iteration and feedback.*[1]

In addition we assume in this paper that by repetition design thinking creates mindsets that in sum build creative confidence. We will discuss this hypothesis later on against the background of the collected data.

2.2 Goals of Design Thinking Education

Design processes always consist of iterative cycles of construction and reflection (Schön 1983). These cycles occur at many levels: minute-by-minute-sketching, daily discussions with colleagues, status meetings, prototyping, reviews by clients and so on (Moran and Carroll 1996). Design thinking education therefore addresses dealing with these cycles from the beginning on: The procedure of learning and the creation of knowledge within design thinking education are based on highly iterative proceedings. These proceedings can be seen in analogy to learning concepts like for instance the "experiential learning theory (ELT)" (Kolb 1984, 1985). The "four-stage-cycle of learning" suggests the following stages: concrete experience,

[1] See website of the d.school in Stanford: http://dschool,stanford.edu/big_picture/design_thinking.php (June 16th 2010)

reflective observation, abstract conceptualization and active experimentation. The "four-stage-cycle" is assumed to be located close to the process of design thinking education.

To educate design thinking, so called d.schools have been built in Stanford and Potsdam. The concept of the d.school was originally developed at Stanford and officially established in 2005. The self proclaimed goal "d.manifesto" of the institution is to "create the best design school" and to prepare "future innovators to be breakthrough thinkers" using "design thinking to inspire multidisciplinary teams". Due to the request of the main sponsor, Hasso Plattner, a sister institute was opened in 2007 in Potsdam, Germany. Within the first years, both institutions worked with employees from the design consultancy IDEO to teach design thinking.

An important principle of the d.schools is to be seen in the fact, that the institutes offer design thinking education intended specifically for non-designers (Dunne & Martin 2006; Plattner et al. 2009).

The d.schools claim that they rather aim at creating innovators than any particular innovation. To achieve this goal, the d.schools employ a group of teaching experts from different disciplines available.

In general, the education is based upon a set of values or mindsets that shape an epistemological view and a methodology for learning.
The basic principles of design thinking education can be summed up as follows (Lande 2010):

- **Human-centered.** Design thinking is a human-centered process. The focus is on making people the source of inspiration and direction for solving design challenges.
- **Mindful of Process**. A critical mindset in design thinking is being "mindful of process" or having metacognitive awareness.
- **Empathy.** Empathy is the intellectual identification with or vicarious experiencing of the feelings, thoughts or attitudes of others. Empathy develops through a process 'needfinding' in which one focuses on discovering peoples' explicit and implicit needs.
- **Culture of Prototyping.** The mindset of creating and maintaining a "culture of prototyping" focuses on being highly experimental, building to think, and engaging people with artifacts.
- **Show Don't Tell**. As a mindset, "show don't tell" takes traditional visualization one step further, as it includes sketching and traditional prototyping, digital communication and storytelling.
- **Bias Toward Action.** Bias Toward Action is a focus on action-oriented behavior rather than discussion-based work. A "bias toward action" mindset utilizes all modalities of learning.
- **Radical Collaboration.** This mindset is built upon the idea that radically diverse multidisciplinary teams will lead to greater innovations than teams that come from the same discipline. Examining and confronting team dynamics is an essential component.

These principals and goals of education are represented by the d.schools in Stanford as well as in Potsdam. Since the early days both schools have built up a strong culture which not only manifests itself within the shared knowledge but also within the language that is coming into being among students and teachers. This "language" became obvious during our interviews: The "d." as a prefix in front of self invented processes and tools, such as "d.camp", "d.teams" and "d.manifesto" can be seen as a strong indicator of the school's culture. Although this aspect is not the main focus of this study we want to draw on this fact to point out the strong believes of the people at both schools in design thinking, creativity and ultimately in their way of working.

Still, there exist slight differences regarding the outcomes of the education. Teachers explained that Stanford students see design thinking as a useful asset to their already developed set of skills, while Potsdam students tend to think of design thinking as a profession. One teacher in Potsdam stated, that 33 Students from one semester left the school and started their own "design thinking" company. Although this impact can only be hypothesized it shows a difference between the teaching-culture of these two institutions.

3 Empirical Research

In order to find out more about the underlying methods and mechanisms of design thinking education, we conducted interviews in design schools in the USA and Germany. The empirical research consisted of two phases, which will be described in this chapter.

The first part describes how data was collected, interviewing teachers in the domain of design thinking education.

In the second part, the data analysis process in which qualitative methods were used will be explained in detail.

3.1 Data Collection Process

The first phase included 17 expert interviews. The goal was to shed light on the tacit knowledge of design thinking education. The study population consisted of

teaching personnel from the d.school in Stanford (USA) and the d.school in Potsdam (Germany). Our data collection process included 8 semi-structured interviews with design thinking teachers (3 female and 5 male) in Potsdam and 9 semi-structured interviews with design thinking teachers (1 female and 8 male) in Stanford. The format of the session was an informal one-to-one meeting.

The interviewees where randomly selected from the current teaching staff. All interviews were conducted within the period of one month.

The interviews were started by asking the experts about their background, their involvement in the d.school and about their level of expertise. After that, interviewees were asked about goals in design thinking education, as well as on their personal understanding of design thinking. To structure the interviews we asked teachers about three different areas of goals in design thinking education.

To give interviewees a better understanding, these categories where explained beforehand as follows:

- Goals of design thinking education in regard of *cognitive knowledge transfer*. This refers to the knowledge that is explicitly taught during classes.
- Goals of design thinking education regarding the *emotional and motivational abilities* students should develop.
- Goals of design thinking education in regard of the *competencies and skills* students should learn. This refers to hard and soft skills, which are crucial to design thinking.
- We also defined one *open category* in which the interviewees had the chance to express other goals, which they felt were different or did not fit in the given categories.
- For the last category they were asked to identify *changes in behavior* as well as learning effects, which were not intended but observed on students while experiencing the design thinking education.

At the same time the interviewees described not only what was done but also why, providing context and explaining the reasons behind their action. So it was possible to ask questions and probe more deeply to ensure understanding.

3.2 Data Analysis Method

In analyzing the data from phase one, we were using a qualitative approach looking to find emergent patterns and significant correlations. Each of the 17 interviews was audio-recorded and analyzed right after each interview. The interview length varied from 26 minutes to 1 and ½ hours. This depended on the participants' level of reflection on their teaching and their willingness to spend time.

After the identification of items, key categories were created grouping similar items (Straus 1998). In addition the findings where written down in memos, covering the key insights of each researcher while still referring to the original sources, making the structuring process more transparent and close to the original sources. This process was conducted by three researchers in parallel. In the end, findings were discussed and memos where revised to form one coherent understanding of the data. In the data we focused on dominant patterns of data, considering plausible and revival explanations, as a technique to build explanations.

This led to the categorization of data to identify the key points as a hypothesis of causation.

4 Key Findings

Within this section key findings will be described which we will later use for a first draft of a coherent model of design thinking as a model to teach design creativity.

4.1 Findings regarding methods and tools

Early in the education process, students are exposed to a basic set of methods and tools for each part of the design thinking process. As they go on learning, more tools and methods are taught, which is why some of the interviewees referred to design thinking as a "tool-belt".

At first, the tools are used on a one-to-one-base. That means, that for each step in the design thinking process students get one tool in the beginning. For example "brainstorming" is taught as a first tool for the ideation phase where they have to come up with creative ideas.

During the education and further project experience additional tools are required, reacting to the situation at hand. These tools are provided by teaching personnel based on their own experience and learned through literature like the "Bootcamp Bootleg" (2009).

Tools are drawn from different areas of expertise, from anthropology and mechanical engineering to supplement tools originated in design and other creative fields. While there is a huge variety of tools described in literature such as "Bootcamp Bootleg" or the Human-Centered Design (HCD) Toolkit (IDEO 2010), the knowledge about them depends on teachers' experience and the students' personal backgrounds.

According to the teachers, tools and methods are taught to foster certain skills in students.

4.2 Findings regarding modes and process steps

Tools and methods are used within certain modes which are represented by steps within the design thinking process. While some teachers (9) use the word process steps, some already used the word modes. This led us to the conclusion that the understanding of modes is also a concept that is just starting to spread among teachers.
In order to perform in a certain mode, students will need to learn appropriate tools. Interviewing the teachers led to a first draft of methods and tools:

- The *emphasize-mode* matches the phases of observe and understand within the process model. Within this mode, students learn how to build empathy in order to better understand and serve people they develop solutions for. In order to reach this aim, tools like interviewing and observation are taught.
- Within the *define-mode* "the goal [...] is to come up with an actionable problem statement" (d.school teaching team, 2010). The goal of this mode is to come up with a narrow problem statement, which seems to be crucial for the ideation phase. The tools mentioned in this regard are persona, vain diagram and two-by-two matrix.
- The *ideation-mode* "is the point in the design process at which we focus on idea generation" (d.school teaching team, 2010). In this phase, tools like brainstorming or body-storming are typically performed and taught as one way to come up with new ideas.
- For the *prototyping-mode* students learn how to generate quick and low resolution artifacts. To do so, students are taught a variety of methods ranging from simple sketching techniques to computer simulations as well as physical prototypes.
- In order to validate their prototypes students are asked to enter a *test-mode*. Within this phase user tests are performed in order to evaluate prototypes and to inspire further development.

A a basic set of creative tools is provided: Brain-storming, drawing and prototyping seemed essential for teachers from all disciplines.

4.3 Findings regarding the process

In the beginning students are exposed to the process and experience the process not in an iterative but rather linear way to follow. According to the teachers, this makes it easier for the students to understand and to internalize it.

To ensure that the process will work, students are exposed to predefined creative challenges, which allow them to experience this process in the simplest form, "stepwise". Teachers explained that the bigger part of the explicit knowledge about the design thinking process is learned within the first weeks of the course. Further acquisitions concerning tools and special skills like project management take place later on.

Interviewees quoted that with the time, the creative challenges increase and the protective environment of the predefined challenges vanishes. Students are more and more exposed to uncertainty. This creates the affordance to act more iterative and even more flexible within the process. This is achieved, for example, by giving the students a vague problem statement, so the challenge they were exposed to is not only to find the right answer, but also to find the right question. These problems were referred to as 'wicked problems' as described by Rittel (1972).

Teachers reported that it is their purpose to change student's behavior from a process-led thinking to a more creative and situation-based mode of working. They achieve this in letting them realize that the certain steps in the process are only stages within a flexible process.

4.4 Findings regarding mindsets

Although mindsets were never explicitly explained, they were mentioned by nine out of eight interviewees and described as "[they are] like an attitude to embody".

Especially Stanford teachers were quite certain that these mindsets play an important role and that they are crucial to develop creative competence. But nevertheless the teachers seemed to be vague according the definitive and the completeness of them:

"I don't know if that fits with mindsets or not, but something like risk taking is what I've been thinking about a lot recently."

Some of the mindsets where specifically mentioned, while none of them was explained in full detail. As described by Micah Lande (2010), already developed mindsets seem to be quite specific on the topic of design thinking. In addition it appeared to us, that the concept of mindsets in design thinking

education is still new and not fully explored nor defined.

4.5 Findings regarding creative confidence

The development of creative confidence was mentioned by almost all interviewees. The most common explanation was a development of trust in one's own creative skills. As stated by one interviewee:

"It's hard when somebody says: Be more confident within yourself! But this stuff is so tangible that you can see success. So if this is like interviewing, you can see yourself having success in that." Another interviewee pointed out that "(…) if I ask students at the beginning of a term: Who of you is creative? Almost nobody raises his/her hand, except some design or art students. When I ask them at the end of the first year, almost everybody says: I'm!"

Furthermore creative confidence was described by some of the teachers (4 out of 18) as an important goal in design thinking education.

By continuously exposing students to creative challenges and by questioning more and more of the initial believes students developed confidence and competence within their creative behavior as the only reliable factors.

In addition teachers talked about several advices they gave to their students which could be seen as fallbacks, preventing students to struggle while dealing with the uncertainties of the creative process. "Point [ing] them to past successes" was seen as helpful to reassure students of their creative behavior. Another advice was to "be mindful of the process". According to the teachers, this is done so that they know in which mode – of the design thinking process - they are and that they are aware of the tools to identify and solve the situation at hand.

4.6 Development of creative confidence and competence through design thinking

According to the explanation of Stanford teachers, the modes explained in the previous chapter are translated into mindsets. According to the teachers and Lande (2010), these modes can be described as automatisms which translate creative thinking into creative acting and vice versa. The repetition of working within these modes and experiencing situations where creativity is needed to master a situation leads to confidence and competence in regards of student's creative behavior.

By discussing the items above, we could show interdependencies between them. In addition we argue that all of these items are functioning as a whole to foster creative thinking and creative acting in students. Some quotes of the interviewees were especially interesting regarding the confidence developed in students.

In essence, teachers describe methods and tools as a way of expressing creative behavior, while the process provides a certain framework and a recommendation of how to deal with certain situations on a cognitive level. In addition, creative mindsets are fostered by repetitively experiencing and applying the process as well as tools according to given problems or developing behavioral patterns in certain situations. These mindsets can be seen as the establishment of a bias towards creative behavior in situations where students are facing situations in which they are uncertain or problems where there is no solution at hand.

Fig. 1. The development of creative confidence in design thinking.

Although these mindsets fall into different categories, they all put an emphasis on creative behavior and creative problem solving.
By experiencing the "process" of design thinking over and over again, students develop a trust in their creative skills, since these were the only ones that could help them to solve the problems they were exposed to.

The process (Fig. 1.) can be described as the development of a creative competence since it teaches students not only to trust their creativity but also the skills to use it to creatively and successfully solve problems in various situations.

This trust in creativity, or - as the d.school teachers call it - creative confidence, is established within the students via the design thinking education.

5 Discussion and Outlook

One of our main assumptions was that by repetition design thinking creates mindsets that in sum build creative confidence. Against the background of the

collected data we regard this hypothesis as validated. Teaching experts described the design thinking education as a progressive movement, which contains several steps. Throughout these steps, different competencies are developed, such as prototyping skills, emotional skills, capability of adopting perspectives, empathy and a certain mindset. The development of these creative competencies culminates in the acquisition of creative confidence, which assures the students of their own ability of acting and thinking creative.

In this regard, if we rely on creativity as the ability to generate innovative ideas, design may be referred to as a way of expressing these in a certain way.

Having this in mind, the way from the top of the pyramid (creative confidence) down to methods and tools might also be described as translating creative design thinking into creative design doing.

Our model (Fig. 2.) gives a first graphical representation about how creative confidence and competence are developed and reinforced in design thinking education. Additional research on the items of each level as well as their interplay will be needed in order to fully understand how they influence each other and what their specific role in the development of a creative confidence might be.

The model provides a framework for future research and an explanation on how creativity and creative acting might interplay - not only within this one approach, namely design thinking, but although within different areas of creative education.

The evaluation of the interviews also confirmed, that there are various ways to achieve this creative confidence. Lindberg et al. (2009) showed that different disciplines already bring in different abilities referring to skills such as visualization or presentation of their specific field. In addition, we believe that students bring different level of expertise in the required mindsets. The interviewees also acknowledged this fact. Thus design thinking is not only one way to enable creative confidence; it moreover offers a way to further develop the different mindsets needed to build creative confidence.

Within our study we experienced almost no coherence in the definitions that teachers gave about design thinking. Explanations about the essence of design thinking ranged from describing it as a toolbox, to describing it as a culture.

Due to our findings we want to propose a definition of design thinking within the teaching context: As a result of this paper design thinking is defined as a learning model which supports design creativity, utilizing a project and process based learning process by emphasizing creative confidence and competence.

Following this definition, design thinking is not a purpose in itself. It allows more flexibility when it comes to further development and the application of design thinking. This was also a basic finding within the interviews. While Stanford teachers described design thinking more towards an open concept, Potsdam teachers were more likely to define it as a process or a set of rules students can stick to.

By defining creative confidence and creative competence as the product of design thinking education, we suggest a bigger picture of the learning-experience that proposes design thinking as a concept for further development within the creative education in design.

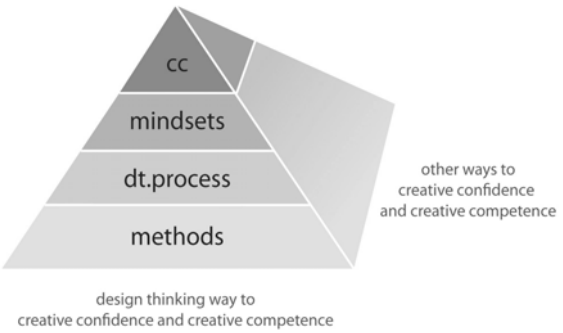

Fig. 2. The development of creative confidence and competence through design thinking and other disciplines.

Furthermore we want to draw attention to the fact that students, depending on their previous education, have already developed some mindsets which teachers can build on and which the creative design education might want to draw on. Drawing on this fact, it can be argued, that a third dimension should be added to our model (Fig. 2), representing other ways to develop creative competence. In addition teachers told us that they utilize knowledge from their own professional backgrounds within the design thinking education which further supports this hypothesis.

Looking at the pyramid from above, creative confidence becomes the center of this model and the core of creative education. While the mindsets might still be related, similarities may vanish when we move further down the pyramid into the different areas of creative tools and methods in each field.

Our future research focuses on the point of view of design thinking students. To complete the study about design thinking education, case studies will be conducted to enlighten the outcomes of the d.school education experienced by the students.

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