**Abstract**
This study provides an overview of the current state of design thinking. Through a review of the literature, the paper surveys the basic viewpoints of design thinking, paying particular attention to the perspective of design research and design education. Two viewpoints are discussed: the “analysis of design” viewpoint and the “human-centered problem solving” one. The necessity of design thinking to be conceptualized and taught in an effective and practical way has been pointed out. Furthermore, the teaching of design thinking should be comprehensive and attempt to develop design-thinking skills to the fullest. Finally, education in design thinking can be seen as an indispensable research “ground” for understanding and enhancing human creativity and innovation in a wide range of fields.

1. **Introduction**

1.1. **Design thinking method**
Design thinking—that is, how designers think—has long been a topic of research and education in the field of design (Lawson, 1980; Rowe, 1987; Cross, 1990; Goldschmidt, 1994; Cross et al., 1996; Dorst, 2010), and more recently, outside this field too (Kelley, 2001). Design thinking has been studied and approached from different standpoints (Cross et al., 1996; Lawson, 2004; Badke-Schaub et al., 2010), and is strongly supported as being applicable even outside the design context (Brown, 2008). However, design thinking as a method has not been well conceptualized (Dorst, 2010).

In attempt to clarify the existing knowledge of design thinking and systematize how it can be taught, this paper overviews the current research on design thinking.

1.2. **Focus and aim**
This paper focuses on the answers of the following questions:
(1) What is design thinking from the viewpoint of design?
(2) What kind of teaching methods are commonly used for education on design thinking?

Through a review of the literature, the paper overviews predominant viewpoints on design thinking, paying particular attention to the perspective of design research and design education.

Thus, this paper consists of two parts. The first part discusses the design-thinking paradigm. The second focuses on the methods currently employed to teach design thinking. Essentially, with this structure, this paper aims to provide up-to-date guidelines for teaching design thinking and developing courses on design thinking from the viewpoint of design education.

2. **Design thinking paradigm**

2.1. **Bases of design thinking**
Design thinking can be described as a paradigm, rather than an example of a method or a methodology. Understanding of the design thinking paradigm is rooted in the analysis of designers’ thinking process. This process has long been in the focus of research efforts to analyze design activities (Lawson, 1980; Cross, 1982; Lawson, 2004).

Thus, the design thinking paradigm includes explicating the specific approach applied by designers in addressing (or providing answers to) the issues in their work (designing). This paradigm extends further and includes how the knowledge of such an approach, applied by designers, can be provided, taught, and applied in addressing (or providing answers to) further issues. Such issues are regarded as “wicked problems” (see Buchanan (1992) and Rittel (1972) previously) or “ill structured problems” (Simon, 1973). Following the notion that among general problems, there are many “wicked” ones, the application of design thinking outside the context of design led to the creation of different viewpoints on design thinking itself.

2.2. **Discourses on design thinking**
The term of “design thinking,” which was used explicitly in the late 1970s and 1980s, was preceded by a more ambiguous concept that can be traced back to the 1960s. According to the interviews of design professionals conducted by Hassi & Laakso (2011), the roots of the term design thinking emerged in the late 1960s. The concept of design thinking is explicitly used

Design thinking includes at least two key viewpoints— that of the designer (or design researcher) and that of the decision makers. Melles clarifies these viewpoints as follows:

“The term design thinking has two current meanings—the study of the practices of working designers—the other meaning refers to the human-centred ‘open’ problem solving process decision makers use to solve real world ‘wicked’ problems.” (Melles, 2010, p.299)

Further, Badke-Schaub et al. (2010) describes this difference in viewpoints as the “traditional design thinking approach” and the “new design thinking movement.” For the purposes of the present research, we term these viewpoints an analysis of design viewpoint and a human-centered problem solving viewpoint, respectively. The two viewpoints and the evolution of their understanding (definitions) are shown in Table 1.

Badke-Schaub et al. (2010) discusses the different viewpoints as follows:

“The traditional design thinking approach has meanwhile produced a broad research history but has to cope with its fragmented variety of empirical results, due to a lack of theoretical integration; the new view on design thinking as management strategy is not grounded on empirical studies or evaluations and suffers from an ambitious and too general concept. Both approaches could gain from each other in different ways.” (Badke-Schaub et al., 2010, p. 39)

These differences in viewpoints raise the question of what is covered by the term “design thinking.”

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Table 1. Development of the viewpoints on design thinking

<table>
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<tr>
<th>Authors</th>
<th>Analysis of design viewpoint on design thinking</th>
<th>Human-centred problem solving viewpoint on design thinking</th>
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<tbody>
<tr>
<td>Stewart (2011)</td>
<td>“Strategies for addressing ‘ill-structured’ and ‘wicked’ problems; an identification originally made by thinkers within the Design Methods movement”</td>
<td>“A tool to aid in the navigation of transition (in this case a transition in the self-understanding, as well as in the operative strategies, of disciplines)”</td>
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<td>Badke-Schaub et al. (2010)</td>
<td>“The traditional design thinking approach;” “Design thinking as the as sequence of operations and structured pattern of processes”</td>
<td>“The new design thinking movement;” “Design thinking as innovation and transformation process for: • disruptive innovation to gain competitive advantage on the global market • to design systems or dealing with abstract problems such as services • human-/user-centered”</td>
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<td>Cross (2010)</td>
<td>“Encompasses many forms of thinking and intelligence;” “Skilled, educated practice of designing”</td>
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<td>Dorst (2010)</td>
<td>“Design thinking is characterized with a kind of abduction process that provide a frame for the connection of ‘how’ and ‘value’ in the equation: ‘what’ plus ‘how’ leads to ‘value’, when ‘what’ and ‘how’ entities are unknown”</td>
<td>“Providing organizations with frameworks of ‘how’ leads to ‘value’ in unknown equitation: ‘what’ plus ‘how’ leads to ‘value’”</td>
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<tr>
<td>Author(s)</td>
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<td>Brown &amp; Wyatt (2010)</td>
<td>“Aimed at consumer insights in depth. Design thinking is inherently optimistic, constructive, and experiential;” “Social challenges require systemic solutions that are grounded in the client’s or customer’s needs”</td>
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<td>Brown (2009)</td>
<td>“A discipline that uses the designer’s sensibility and methods to match people’s needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity”</td>
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<td>Kelley (2006)</td>
<td>“The Design Process specifies procedures which seek creative success through providing a client with innovative and unique design solutions to a defined project, done on rational grounds, through an agreed-upon process”</td>
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<td>Dym et al. (2005)</td>
<td>“Design thinking reflects the complex processes of inquiry and learning that designers perform in a systems context, making decisions as they proceed, often working collaboratively on teams in a social process, and “speaking” several languages with each other (and to themselves)”</td>
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<td>Lawson (2004)</td>
<td>“‘Framing’ process is an important and central feature of design thinking;” “Moving’ phase of design thinking;” Memory has role in understanding design thinking</td>
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<tr>
<td>Kelley (2001)</td>
<td>“Continuously refined methodology” comprising the steps: “Understand, Observe, Visualize, Evaluate and refine, and Implement”</td>
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<td>Oxman (1999)</td>
<td>“Thinking processes employing both visual and conceptual knowledge;” “Fundamental dialectic process of design thinking;” “Emergence of conscious access to knowledge structures;” “The interaction between visual and conceptual content in global strategies of design thinking”</td>
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<td>Buchanan (1992)</td>
<td>“Design thinking is wicked problem approach;” “Design problems are “indeterminate” and “wicked” because design has no special subject matter of its own apart from what a designer conceives it to be. The subject matter of design is potentially universal in scope, because design thinking may be applied to any area of human experience”</td>
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### 3. Analysis of design thinking

The scope of the term “design thinking” can be summarized as follows.

According to more than three decades of research on the topic (see Table 1, columns 2 and 3), the designer-specific approach (may) include the following:

- shifting attention to parts of the problem
- way of knowing
- reflective thinking in action
- periodic and dialog style of inquiry
- use of various specific types of thinking and media
- wicked problems approach
- abduction with unknown entities
- activities beyond framework of problem solving
- encompassing many types of skills and intelligence

<table>
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<th>Description</th>
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<td>Cross (1990)</td>
<td>“Produce novel unexpected solutions, tolerate uncertainty, work with incomplete information, apply imagination and constructive forethought to practical problems and use drawings and other modelling media as a means of problem solving; “Must be able to resolve ill-defined problems, adopt solution focusing strategies, employ abductive/productive/appositional thinking and use non-verbal, graphic and spatial modeling media”</td>
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| Rowe (1987, p. 34) | “Design thinking” is essential method that have specific “style of inquiry” and “nature”:  
• movement back and forth between exploration and evaluation  
• periodic unfettered speculation  
• “dialogue” between designer and situation  
• final less pronounced episodic character |
| Cross (1982) | “Designerly ways of knowing;” “Design has its own things to know, ways of knowing them, and ways of finding out about them” |
| Lawson (1980) | “How designers think;” “The centre of design thinking, for the way in which the designer chooses to shift attention from one part of the problem to another is central to the design strategy” |
| Simon (1969) | “Theory of thinking;” “Thinking how it adapts itself, through individual learning and social transmission of knowledge, to the requirements of the task environment;” “Use of representations in thinking” |

These points are not exhaustive, but nevertheless give an idea of the diversity in the understanding of design thinking from a historical perspective. Because of the ambiguous and constantly evolving nature of design thinking, it seems impossible to provide a conclusive description of its scope. Consequently, the question now arises as to how the knowledge of the design thinking approach can be provided, taught, and applied.
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<tr>
<th>Authors</th>
<th>The aims/goals of the teaching design thinking</th>
<th>Essential requirements for teaching design thinking</th>
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<tr>
<td>Melles (2010)</td>
<td>“A project-oriented semester long course with relevant readings and mid-point assessment of projects, outcomes and aims to expand the designerly basis of undergraduate designers” Moreover: • Form a part of a broader base of foundation studies for such students • Need for a mixture of project work and readings in curriculum design • Address real world problems</td>
<td>Reports, mini-tests and presentations on: “Applying design thinking strategies and concepts to real-world problems” via “Developing expertise in the framing and solution of real world problems using design thinking;” “Developing expertise in the range of tools and methods used to solve such problems and demonstrate this;” “Communicating design thinking applied to a specific context in the public setting.” Moreover: • Combined human-oriented, service-scoped designerly outcomes • Milestones through the semester stage the process and feedback possibilities • Projects undertaken by groups of students in on-campus locations, where human, space and product innovations are required • Embracing all issues and follows a process</td>
</tr>
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<td>Dym et al. (2005)</td>
<td>Developing thinking about designing systems in the following: 1) Thinking about system dynamics 2) Reasoning about uncertainty 3) Making estimates 4) Conducting experiments</td>
<td>“Effectively implementing project-based design education;” “New approaches are needed to assess the underlying theme of design learning for both emerging paradigms of design thinking and new modalities of design pedagogy”</td>
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<tr>
<td>Oxman (2004)</td>
<td>Cognitive-based teaching approaches in design education: • Have to treat “the cognitive processes of design thinking as a form of explicit teaching content” • “Teach how to construct knowledge related to designs, or designing” • “Use of appropriate representations of concepts, conceptual structures, and conceptual knowledge”</td>
<td>“The student functions as a design researcher while learning about design, in addition to how to design;” “Build a conceptual understanding of the knowledge domain;” “The acquisition and the construction of the body of concepts from precedents is considered as means to demonstrate and facilitate meaningful learning”</td>
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<td>Oxman (1999)</td>
<td>Aims at cognitive orientation to design reasoning as a foundation of design learning. “Cognitive design media:” The approach is “based upon the student’s exploration of the design problem’s conceptual space and the formulation of knowledge structures which are related to potential solution spaces”</td>
<td>“Reflection on the problem in the medium of conceptual drawings;” “Definition of the distinction between the interactive modes of visual reasoning and design ideation;” “The interaction between student and tutor becomes more of a participatory process in which the articulation of principle during the dialectical process of design becomes the responsibility of the tutor as an articulator of the values and issues which motivate changes in the subsequent stages of the design representation as a process of search”</td>
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Table 2. Practices of teaching design thinking
4. Analysis of the practices used in teaching design thinking

Research on the practices used in teaching design thinking, however, is surprisingly scarce. Table 2 provides a list of some notable studies on teaching design thinking, providing a timeline of the research on teaching design thinking in general.

4.1. Teaching methods for design thinking

Pedagogical frameworks for teaching design thinking need to be developed. Teaching approaches addressing some of the aspects of design thinking described above (Oxman, 2004) or models of teaching design thinking exist. Currently, project-based learning (PBL), which was explored by Dym et al. (2005), is the most favored of these for teaching design thinking.

Melles (2010) describes a newly developed design thinking university course as “a project-oriented semester long course with relevant readings and mid-point assessment of projects, outcomes and aims to expand the designerly basis of undergraduate designers” (Table 2). Moreover, this course is characterized by a broader base of foundation studies for such students, a curriculum combining project work and reading, and attempts to address real-world problems. Emphasis is placed on combined human-oriented service-scoped outcomes, milestones, and feedbacks; human, space, and product innovations; and an all-embracing perspective.

Teaching divergent inquiry in design thinking, Dym et al. (2005) defines thinking about designing systems as having the following steps of thinking about system dynamics: reasoning about uncertainty, making estimates, and conducting experiments. These two examples are effectively implemented in project-based design.

Furthermore, new approaches are needed to assess the underlying theme of design learning for both the emerging paradigms of design thinking and new modalities of design pedagogy (Dym et al., 2005). Oxman (2004) discusses cognitive-based teaching approaches in design education. The cognitive processes of design thinking have to be treated as explicit content of teaching, focusing on how to construct knowledge related to designing or the object of design (Table 2). Moreover, a means of demonstrating and facilitating meaningful learning could be to build a conceptual understanding aimed at the acquisition and construction of a body of concepts from their precedents (ibid).

Programs focus on training students on how to create innovative services or products, particularly systematic and
team-based idea creation, exploring the viewpoint of users, idea sharing using prototypes, and the development of effective communication to express the ideas (Ishii et al., 2009). The three steps of “understanding,” “creating,” and “realizing” have been considered indispensable for the attainment of in-depth understanding of humanity and society, idea and prototype development, and truly feasible strategic planning, through team-based collaboration (i.school Annual Report, 2011, p. 2). These characteristics of learning indicate the goal of education on design thinking—enhancing creativity.

Thus, this learning should engage design students’ inner senses and emotions (Taura & Nagai, 2011). As design thinking depends on the inner senses of the designer, it relates also to the designer’s motivation (Taura & Nagai, 2012).

4.2. Guidelines for courses on design thinking
An overview of some of the first courses on design thinking can be found in Melles (2010). The newly developed course on design thinking has the following key characteristics:

- “Majority of readings still employing design-oriented texts”
- Lectures “focus on design and innovation issues”
- “Degree project work and industry involvement varies with the level of the course—undergraduate or postgraduate”
- “Use of visualisation tools and other strategies, including prototyping, familiar to design students”

The course is focus on application of design to resolve wicked problems, and requires students to come up with practical user-oriented solutions to such problems.

Furthermore, a systematic understanding of the features of the concept generation process (Taura et al., 2012), and approaches that can be employed in reflecting on one’s own design activities (Nagai et al., 2011) should be incorporated in courses on design thinking.

4.3. Practice outside the framework of design
The human-centered problem solving approach has been used to tackle social challenges that require systemic solutions, and that are grounded in the client’s or customer’s needs (Brown & Wyatt, 2010). Such practices are used with an intention to gain in-depth consumer understanding through design thinking, which is an inherently optimistic, constructive, and experiential process that relies on local expertise.

5. Discussion
The main characteristics of the approach can be summarized as including certain logic (abduction), inquiry (style of), a need for reflection (of own activities) and skills, relationships with patterns and structures, a focus on practice, and attempts to wicked (uncertain, ill-structured) problems (Figure 1). Consequently, a key question arises: how can such skills and knowledge be taught?

Applications of the teaching of the design thinking approach are sought in the following areas:
- Design education (Dym et al., 2005; Melles et al., 2012)
- Other types of education (e.g., management (Skaggs et al., 2009))

In recent years, differences in discourses on design thinking have been increasingly discussed (Badke-Schaub et al., 2010; Stewart, 2011). However, the common target is teaching design thinking.

Therefore, the future challenge in design thinking is to provide a concise theoretical and practical framework for design thinking to be taught effectively. Design thinking needs to be established as a discipline in the future, a discipline that plays a fundamental role in learning about and addressing unstructured real-world problems.

6. Conclusions
First, design thinking should be clearly conceptualized and taught in an effective and practical way. The teaching of design thinking should embrace all aspects of design and attempt to develop design-thinking skills to the fullest. Reduction or simplification of the approach of design thinking usually greatly reduces its effectiveness.

Next, further research efforts are needed to develop design thinking methods and practices by conducting studies in the design thinking classroom. Such an opportunity can be obtained owing to the inherent features of the approach as (self- and team-) reflective and by providing sufficient representations of the occurred processes (e.g. sketches, think maps etc.). Hence, design thinking, specifically education in design thinking, can be seen as an indispensable research “ground” for understanding and enhancing human creativity and innovation in a wide range of fields.

References


