Design Thinking pedagogy: the Educational Design Ladder

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ABSTRACT
As global industries change and technology advances, traditional education systems might no longer be able to supply companies with graduates who possess an appropriate mix of skills and experience. The recent increased interest in Design Thinking as an approach to innovation has resulted in its adoption by non-design-trained professionals. This development necessitates a new method of teaching Design Thinking and its related skills and processes. As a basis for such a method, this research investigated 51 selected courses across 28 international universities to determine what Design Thinking is being taught (content), and how it is being taught (assessment and learning modes). To support the teaching and assessment of Design Thinking, this paper presents The Educational Design Ladder, an innovative resource/model that provides a process for the organisation and structuring of units for a multidisciplinary Design Thinking programme.

Introduction
As do companies around the globe, many educational institutions are required to compete internationally and, therefore, are investing in education systems that emphasise leading through innovation (Beckman & Barry, 2007). The ability to innovate requires a company to evolve, adapt, and be flexible and constantly improving in order to survive and thrive (Morris, 2009). Bucolo, Wrigley, and Matthews (2012) explain that as firms build awareness of different innovation strategies, tools and processes, the successful adopting and embedding of these approaches within their organisation requires changes at all levels of the business. This demand not only requires strong management leadership, it also requires employees with the skills and attitudes to nurture and embrace a business culture of innovation and change.

To meet these demands, and to develop the appropriate capabilities and skills to operate in twenty-first century companies, new learning approaches are required nationally and internationally across all fields of study. As the UK Design Council (2010, p. 13) states: ‘A supply of differently skilled people drives innovation.’ Skills that are increasingly valued by companies in all sectors include creativity, flexibility and adaptability, communication, and management and leadership skills that can be deployed within teams and the entire organisation (UK Design Council, 2010).

Design enhances the outcomes of numerous innovation activities, bringing benefits such as increased quality of goods and services, improved production flexibility and reduced material costs (Cox, 2005). For these reasons, design is increasingly being viewed as a vital and important strategic business resource (Dell’Era, Marchesi, & Verganti, 2010). Thus, universities are increasingly investing in
design schools and programmes to embed Design Thinking throughout the curriculum as a way for students to experience multidisciplinary teamwork that exposes them to skills and knowledge beyond their own disciplines in a safe learning environment. Indeed, Business Schools and Design Faculties have developed specific courses to teach Design Thinking and Innovation. However, as Wong (2009) states, ‘Design Thinking brings creative techniques to business ... but no one can agree on how to teach its methods’. He claims that, while graduates trained in Design Thinking are emerging from interdisciplinary Masters’ programmes that integrate design, technology and business, the argument as to how Design Thinking should be taught continues. One contentious issue, he notes, is whether design should take a more business approach, or whether business should integrate more creative thinking approaches (Wong, 2009).

To address this issue, this paper proposes an approach to the organisation and structuring of a Design Thinking programme that can be applied across disciplines. This approach is based on the findings of an investigation of the current curriculum content, teaching/learning modes and assessment practices of 28 international institutions that currently teach Design Thinking from a multidisciplinary perspective. This investigation revealed five different thematic levels or foci in the Design Thinking process. These five levels or foci form the basis of The Educational Design Ladder model presented and discussed in this paper. This model acts as an educational resource by suggesting content, assessment and teaching/learning modes for each of the five levels to create units or courses for a university-wide Design Thinking programme.

The shift of design thinking

The complex concept of Design Thinking has been documented and debated over the past half century. It is broadly described as a style of thinking, or as the study of the cognitive processes that are subsequently manifested in design action (Cross, 2007). Dunne and Martin (2006) distinguish design from Design Thinking, describing Design Thinking as cognitive processes that designers use, as opposed to the designed objects they produce. It is generally considered as the ability to combine empathy, creativity and rationality to analyse and fit solutions to particular contexts.

The concept of Design Thinking within the academic dialogue of design has been under discussion for more than 30 years, with Schön (1983) and Lawson (2005) describing and reflecting on how designers think. Buchanan (1992), furthermore, created the conversation around ‘wicked problems’ in design, arguing that designers deal with problems that are ill-defined, and that the creative re-definition of the problem is part of the professional skill. Some business problems, for example, have been labelled as wicked problems; for example, when a problem involves many stakeholders with conflicting priorities.

More recently, Design Thinking has been closely related to innovation, and discussion of its application is widespread in both design and management circles. The discussion's changed focus is on how business can use Design Thinking, and this focus is becoming somewhat of a trend in the executive and management research realm and the popular business press. This change is strongly supported by IDEO (a design innovation consulting firm) and the Stanford D-school (Institute of Design at Stanford University), where Design Thinking is conceptualised as a specific way that non-designers evaluate and use design methods. In other words, the shift in Design Thinking through theory and practice has been from design as a science to design as a mindset (Johansson-Sköldberg, Woodilla, & Çetinkaya, 2013). Many different Design Thinking processes have been modelled in the recent literature; the Danish Design Ladder (Figure 1) effectively illustrates this shift.

The Danish Design Ladder, developed by the Danish Design Centre (Kretzschmar, 2003), is a four-step model used to measure the level of design activity in Danish businesses, based on their attitudes to design. The higher up the ladder, the greater the strategic value that design has within the company (Kretzschmar, 2003). Used as a framework, the ladder aims to demonstrate the extent to which design can enhance creativity, innovation and competitiveness. Through design intervention programmes, the value of design is questioned, challenged and slowly shifted further up the ladder over time. In other words, the four steps illustrate four stages of design maturity:
Step 1: No Design – no tangible approach to design.
Step 2: Design as Style – relevant in aesthetic considerations such as style, appearance and Ergonomics.
Step 3: Design as Process – considered as a process or method in product or service output, only embedded in the initial stages of development; design solution is procured externally and is adapted to the requirements of the end user, using a multidisciplinary approach.
Step 4: Design as Strategy – integral to a company’s continuous renewal of their business concept as a means of encouraging innovation; process is fused with the company’s key objectives, and plays a role in every stage of development.

Design thinking in education

As Design Thinking is adapted into the business landscape, universities are attempting to keep apace by teaching and supporting multidisciplinary approaches to solving problems. The first two schools of Design Thinking were the D.School at Stanford University in California’s Silicon Valley, and the D-School of the Hasso-Plattner-Institute in Potsdam, Germany. The D.School was launched in 2005 and was designed to ignite creativity and collaboration. These schools educate students from different disciplines – such as engineering, medicine, business, the humanities and education – to work together to solve big problems in a human-centred approach. Programmes within the course are co-taught by professors from design and business departments, bring together students from different universities for cross-disciplinary project work, and involve collaboration with different areas such as companies, start-ups, schools, non-profits and the government.

Another approach to Design Thinking is the offering of dual degrees in Business Administration and Design, such as the MBA and Masters in Design at Illinois Institute of Technology. Furthermore, short courses on Design Thinking and Innovation have also become popular, and provide a sought-after mix of multidisciplinary skills. By allowing design students to experience working with business, science, technology and engineering, the gaps in knowledge of individual team members are bridged. Working across faculties also provides more opportunities to engage in real-world projects that provide valuable
practice and professional development through a deeper understanding of real-life project management, expectations and professionalism.

To understand more specific approaches to Design Thinking in education, this study investigated what is taught (content) and how it is taught (assessment and learning modes) in universities worldwide.

**Research approach**

The research approach to investigating what and how Design Thinking is being taught in Design and Business courses and units in universities around the world, began with the use of Internet search engines, and a review of the education literature and research reports. More specifically, the search began with Bloomberg Businessweek’s World’s Best Design Programmes (Wong, 2009), which outlines 30 courses considered to be leaders in integrating Design Thinking and Business. A further, more in-depth search was conducted to obtain information about Design Thinking in a number of different disciplines that spanned business, management and entrepreneurship.

The search of international universities also examined programmes and courses around innovation and creativity, as well as general management and education programmes. This further investigation resulted in an additional 21 courses that were not listed by Bloomberg. In total, 51 selected courses across 28 international universities were reviewed. Course information was mapped onto a predesigned data sheet developed (by the researchers) to ensure consistency of the data collected. Each course was outlined by institution name, location, school or faculty, course name, unit outline, course aims and objectives, and assessment processes.

All data was collected from third-party resources such as websites and online publications. The availability of online resources differed across institutions: some provided a brief unit synopsis of what and how learning objectives were assessed, while others included the scope of the programme and its week-by-week learning activities. To ensure the reliability of online course material, information was only gathered from reputable sources such as the university’s website, and only from documents that carried the university logo or name. A thematic analysis (Gavin, 2008) of the data was conducted to identify categories. The analysis process involved coding course content to expose common themes (Braun & Clarke, 2006).

**Results**

Five key themes resulted from the analysis of what (content) Design Thinking was taught, and of how (assessment and learning modes) it was taught. These themes are: (i) theories, methods and philosophies, (ii) product focus, (iii) design management, (iv) business management and (v) professional development. Each of these themes is discussed in detail below.

**Theories, methods and philosophies**

The first theme – theories, methods and philosophies – is the main theme in three courses: Design and Creative Thinking (Queensland University of Technology, Brisbane); Design Thinking (University of Sydney, Sydney); and Design Theory and Methodology (Delft University of Technology, The Netherlands). The commonality of these three courses is that each exclusively explores theories, methods and philosophies of Design Thinking. Other similar courses, such as Design Thinking in Business offered by Aalto University (Helsinki), also cover the history and evolution of Design Thinking to provide a theoretical background and foundation.

The aims of these courses are for students to understand the differences between models, theories and practices of design; to think critically about their value; and to reflect consciously and critically on different design approaches. In all of these courses, therefore, Design Thinking is explored as a highly reflective creative process to allow students to review and think critically about their own design processes, in order to create a deeper understanding of the evolution of Design Thinking as a problem
solving activity. Theoretical and methodological foundations of design are also explored in depth, and current debates on practices are evaluated. Learning outcomes include students’ development of their own attitudes, behaviours and thinking styles as designers, and the ability to challenge any preconceptions.

Product focus

The second theme that emerged has a focus on new product design and development. All courses in this theme are within design faculties and disciplines such as Architecture, Engineering and Industrial Design. The aims of these courses include the development of skills such as sketching, physical prototyping, brainstorming, user-focused thinking, aesthetics and the implementation of a design process (discovery, interpretation, ideation, experimentation and evolution of design solutions).

Design management

Design management courses provide students with the core concepts in, and analytical frameworks for the management of new product development from a marketing perspective, within complex environments and global product and service markets. In the Masters of Product Design and Development (Northwestern University, Illinois), one half of the subjects are devoted to basic business management issues, while the other half are devoted to advanced managerial concepts in design and development. Similarly, the Masters in Product Development (Carnegie Mellon University, Pittsburgh) aims to give students a better understanding of the interdisciplinary approach required to bring successful products to market, and to thus produce accomplished practitioners and leaders in the product development process. To this end, students are required to select units in Design Engineering and Business. Most of the courses are interdisciplinary programmes, and this enables collaboration with the Department of Mechanical Engineering, the School of Design and Business schools.

Business management

Most of the courses in the Business Management category aim to understand the interrelationship between design, business and technology, so as to exploit their collective value. Thus, Design Thinking is specifically used to generate innovative solutions and competitive advantages in an organisational context.

Courses such as Masters of Design Scheme (Hong Kong, Polytechnic University), Strategic Management (University of Sydney), and MBA Design Works at the Rotman School of Management (University of Toronto) are examples of courses that incorporate Design Thinking into Business Management and Strategy. These courses practise Design Thinking as an alternative to the analytical methods traditionally used in business. The school of Business at the University of Virginia, for example, teaches ‘Design Thinking for Business Innovation’, a course that aims to introduce Design Thinking as a complementary decision-making process. Meanwhile, at the Rotman School of Management, students are taught to use Design Thinking as a human-centred approach to tackling complex business challenges.

Professional development

The final theme, professional development, is embedded in courses with a focus on entrepreneurship, leadership, and professional and personal development. The goal of these courses is to help the student develop their own vision, recognise opportunities and execute their innovative ideas in creative design. These courses explain that innovative ideas must be championed or nurtured, and espouse that entrepreneurial approaches make this possible.

They do this by providing the advanced knowledge and practical skills that are required to assess and implement new ideas, to create and manage both innovative projects, and the supportive environments
that foster and enable them. Experimental use of design tools and methodologies aim to build sustainable organisations through individual and organisational leadership. Through professional and personal development topics, and engagement with different teaching modes such as ongoing peer coaching, these courses aim to provide students with the ability to adapt within a business environment that fosters innovation and project management skills. Finally, by adopting a Design Thinking approach, entrepreneurs can collaboratively create potential innovations to create sustainable strategic advantages with a global outlook.

RMIT’s (Melbourne) course in Communication Design Entrepreneurship, for example, provides experiential-based learning and theoretical frameworks that enable design managers to navigate a course of action in highly competitive marketplaces. Meanwhile, the Domus Academy (Italy) offers a Design and Entrepreneurship summer course that is motivated by the belief that young entrepreneurs with innovative ideas and design concepts are the key drivers of future business. Similarly, the University of Adelaide’s Masters of Applied Innovation and Entrepreneurship aims to develop and inspire creative individuals with an interest in starting or developing innovative ventures that have the potential to have a significant impact on markets, economies and communities.

Discussion

The five themes discussed above provide the various topics, assessment practices and teaching modes used in the teaching of Design Thinking. Most significantly, these themes indicate a clear progression in Design Thinking knowledge.

The first theme – Theories, Methods and Philosophies – provides the foundation for Design Thinking as a method whereby students gain skills in critical analysis and reflection that allow them to create their own design process. The second theme, Product Focus, positions Design Thinking as a process for New Product Development, using a human-centred approach to gain an understanding of user needs and requirements at the project level. The main topics covered, and the skills built into these courses, can be closely related to those seen in Industrial and Product Design, such as sketching, form and function, concept development, aesthetics and ergonomics. The third theme of Design Management then places Design Thinking into a broader context, by considering product management, and non-product specifics, including marketing, financial issues, environmental requirements and the management of a product launch. The Business Management theme takes this focus to the next step, with its use of Design Thinking as Business Innovation and Strategy. All elements of a business, from business plans to forecasting, are covered in this category. The fifth and final theme, Professional Development, contextualises the individual, within the course content, aiming to create leaders who recognise the importance of Design Thinking, and who can nurture and support ideas to fruition.

In conjunction with the principles of the Danish Design Thinking ladder (Figure 1), these five themes (or stages) form the basis of the Educational Design Ladder that illustrates the development of Design Thinking in a graduated process, and thus guides the development of Design Thinking course content, and its teaching/learning and assessment processes.

**Educational Design Ladder: themes and principles**

The Educational Design Ladder (Figure 2) has been developed to illustrate the pedagogical stages in the development of Design Thinking. The aim of the ladder is to stage the delivery of Design Thinking content and to progressively guide students to the final step, where professional and personal development and design leadership are the focus. By working through this five-step model, students gain the knowledge and skills to apply design thinking to a range of different contexts and projects. These steps are detailed below.

**Step one (foundation level):** This step provides students with knowledge of the history, evolution and use of Design Thinking. Units illustrate the process of Design
Thinking by employing and utilising its methodologies, philosophies and reflective practices.

Step two (product level): Units in this step place Design Thinking in the product design context. They provide for the practical application of Design Thinking methods and processes to tangible outcomes in product and service design and delivery.

Step three (project level): This step bridges the link between product-focused Design Thinking and design management. Design Thinking is now applied to factors that influence the broader design context, such as the market situation and branding decisions.

Step four (business level): Step Four elevates Design Thinking to the area of business strategy, and incorporates design, business and technology in the development of new business models and strategic forecasting.

Step five (professional level): The final step removes Design Thinking from a specific context and aims to develop a student’s personal and professional skills. It uses Design Thinking to demonstrate the importance of developing the skills to recognise opportunities, and to nurture the process of bringing innovative ideas to fruition.

Educational Design Ladder: structured pedagogy and curriculum

To facilitate its service as a holistic and practical Design Thinking curriculum development and delivery guide, the concept of constructive alignment was then applied to the Educational Design Ladder. ‘Constructive alignment’ is the process of placing key curriculum elements – objectives, teaching/
learning activities and assessment tasks – into a structured, cohesive system (Biggs, 1996). To this end, Biggs’ SOLO taxonomy – the Structure of the Observed Learning Outcome (Biggs, 1996) – depicts the cumulative nature of learning, and the nature of some major transitions in the learning process. The SOLO model provides a hierarchical framework, the specific levels of which can be defined to suit the unit content and level being planned (Biggs, 1996).

The purpose of integrating Biggs (1996) SOLO taxonomy within the Educational Design Ladder (Figure 3) is to facilitate the design of a curriculum that progresses students through the five themes/stages of Design Thinking. The units within the ladder increase in complexity as the students’ understanding of Design Thinking increases with each stage. The SOLO levels can be used to develop curriculum objectives within each stage, and are a means of classifying learning outcomes in terms of their complexity. This, in turn, enables students’ work to be assessed for higher order thinking skills, rather than for knowledge retention alone.
Table 1. Educational Design Ladder pedagogy and curriculum.

<table>
<thead>
<tr>
<th>Step</th>
<th>Knowledge D.T level Theme</th>
<th>SOLO taxonomy Description</th>
<th>Activity</th>
<th>Verbs</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factual</td>
<td>Application</td>
<td>Multiple-choice test, recount facts or statistics, recall a process, rules, definitions; quote law or procedure. Explain or interpret meaning from a given scenario or statement, suggest treatment, reaction or solution to given problem, create examples or metaphors</td>
<td>Arrange, define, describe, label, list, memories, recognise, relate, reproduce, select, explain, reiterate, reward, critique, classify, summaries, illustrate, translate</td>
<td>Reflection, ideation, design process, design history, defining design, creative thinking (idea generation), group dynamics, wicker problems, design contexts, visualisation, experimentation, prototyping</td>
</tr>
<tr>
<td>1</td>
<td>Foundation level Theories, methods and philosophies</td>
<td>Recall or recognise information. Understand meaning, re-state data in one's own words, interpret, extrapolate, translate</td>
<td>Place theory into practice. Demonstrate, solve and manage a design project/s</td>
<td>Use, apply, discover, manage, execute, solve, produce, implement, construct, change, prepare, conduct, perform, react, respond, role-play</td>
<td>Idea generation, user focus, concepts, aesthetics, communicating visually, iterate and evolve design theoretical and practical aspects of design, sketching, form and function</td>
</tr>
<tr>
<td>2</td>
<td>Conceptual Product level Product content design</td>
<td>Use or apply knowledge, put theory into practice, use knowledge in response to real circumstances</td>
<td>Analyse, break down, catalogue, compare, quantify, measure, test, examine, experiment, relate, graph, diagram, plot, extrapolate, value, divide</td>
<td>Analyse, break down, catalogue, compare, quantify, measure, test, examine, experiment, relate, graph, diagram, plot, extrapolate, value, divide</td>
<td>New product design and development, project management, marketing research, market identification and requirements, opportunity mapping, scenario planning, capital and variable costs, environmental requirements</td>
</tr>
<tr>
<td>3</td>
<td>Conceptual Project level Design management</td>
<td>Interpret elements, organisational principles, structure, construction, internal relationships; quality, reliability of individual components</td>
<td>Develop plans or procedures, design solutions, integrate methods, resources, ideas, parts; create teams or new approaches, write protocols or contingencies. Review strategic options or plans in terms of efficacy, return on investment or cost-effectiveness</td>
<td>Analyse, break down, catalogue, compare, quantify, measure, test, examine, experiment, relate, graph, diagram, plot, extrapolate, value, divide</td>
<td>New product design and development, project management, marketing research, market identification and requirements, opportunity mapping, scenario planning, capital and variable costs, environmental requirements</td>
</tr>
<tr>
<td>4</td>
<td>Procedural Business level Business strategy</td>
<td>Develop new unique structures, systems, models, approaches, ideas; creative thinking, operations</td>
<td>Develop plans or procedures, design solutions, integrate methods, resources, ideas, parts; create teams or new approaches, write protocols or contingencies. Review strategic options or plans in terms of efficacy, return on investment or cost-effectiveness</td>
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</tr>
<tr>
<td>5</td>
<td>Metacognitive Professional level Personal development and leadership</td>
<td>Evaluation</td>
<td>Assess effectiveness of whole concepts, in relation to values, outputs, efficacy, viability; critical thinking, strategic comparison and review</td>
<td>Develop personal and professional skills. Demonstrate the importance of developing the correct skills to recognise opportunities and nurture the process of bringing innovative ideas to fruition</td>
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(Continued)
The five stages of Design Thinking also reflect Säljö's (1979) conceptions of learning, with an emphasis on making connections and contextualising theories, with the assumption that each level embraces previous levels and learning, and builds upon them. The knowledge dimension classifies four types of knowledge that learners might be expected to acquire or construct: factual, conceptual, procedural and metacognitive.

Table 1 now explores each step of the Educational Design Ladder in detail. It does this by outlining – for each of the five steps – the type of knowledge acquired (that is, factual, conceptual, procedural or metacognitive); the Design Thinking level (that is, foundation, product, project, business or professional level); the theme or topic that is the focus of the teaching/learning (that is, according to the five stages previously determined and explored); the SOLO taxonomy level of cognitive skill; a description of the specific cognitive skills developed within this level; key activities that apply these skills to the practical context; key verbs or actions required when undertaking these activities; the topic, theme/topic being taught/learned; teaching/learning modes and processes; and assessment examples.

As education modes are changing from a teacher-led approach (that focuses on content delivery and assessable outcomes), to a learner-based approach (that encourages self-directed, peer tutored, and cooperative learning) (Biggs & Tang, 2007), new pedagogical approaches are required in order to integrate Design Thinking into the teaching of all disciplines. The Educational Design Ladder reveals that in order to successfully cross disciplines, design projects should involve authentic, hands-on tasks; possess clearly defined outcomes that allow for multiple solutions; promote student-centred, collaborative work and higher order thinking; allow for multiple design iterations to improve the product; and have clear links to a limited number of science and engineering concepts.

The Educational Design Ladder has several implications for teaching and learning in Design Thinking courses. It suggests:

- A peer learning and teaching approach.
- Student IP ownership of their stake in the projects undertaken.
- The necessity for student interaction to attain educational goals.
- That knowledge is acquired through actions and practice, rather than traditional instructional learning.
- That assessment should be based around the willingness to take risks and to try new things.
- That an action learning coach or facilitator (tutor) be involved in the Design Thinking process and projects to inspire, motivate and act as confidante.
- That project work should take a problem-based and studio-based approach.
• That studio learning should immerse students in an environment of reflective creative practice, with the guidance of a practitioner/educator (Schön, 1983).
• The need for cross-disciplinary teaching teams from design, business, engineering and information technology.
• That cross-disciplinary project work is necessary for developing and sharing skillsets.
• The need for real-world problems to solve, for real clients and real responsibility.

Summary and future research

To keep abreast of the changes in business landscapes, new pedagogical approaches are required to provide students with the skills and attitudes that companies now value. This study provides such an approach, with a holistic classification of Design Thinking educational content – an approach that can be seen as the first step in developing a multi-disciplinary Design Thinking curriculum. Specifically, the Educational Design Ladder presented in this paper provides a structure for, and classification of the key stages in a cross-disciplinary undergraduate curriculum.

While creating an interdisciplinary programme is not a simple process, the Design Thinking units developed and outlined here demonstrate how the key skills required of the twenty-first century graduate across all industries, can be embedded in the content, teaching/learning processes, and learning outcomes of an undergraduate curriculum. In other words, the Educational Design Ladder provides a scaffold for organising and structuring Design Thinking units or courses in multidisciplinary contexts.

A limitation of this study is the nature of the secondary data sources employed and the time period in which it was collected (2013). While this study is able to provide a broad overview, it is unable to reveal the relationship between the various courses provided by the various universities, or the success of these courses. Further research is required to assess the implementation of the Educational Design Ladder in the development of a cross-disciplinary Design Thinking programme.

Notes on contributors

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Kara Straker completed her undergraduate degree in Industrial Design and is currently completing her PhD. Her research is cross-faculty, engaging with industry and academics across the fields of design, information systems and business.

References


