



## UNDERSTANDING DESIGN THINKING IN DESIGN STUDIES (2006 - 2015): A SYSTEMATIC MAPPING STUDY

D. Paula and K. Cormican

*Keywords: mapping study, design thinking, empirical study, design research*

### 1. Introduction

Design Thinking (DT) has been studied in many research areas, such as Information Technology (IT), Psychology and Philosophy. Brown [2009] has defined Design Thinking as “*bringing designers’ principles, approaches, methods, and tools to problem-solving*”. Design Thinking practices help organisations to solve complex problems by reducing bias, encouraging innovation and inspiring people to become more creative [Liedtka 2011]. By making Design Thinking a strategy component, many organisations throughout the world – such as Google and Apple – are leading through innovation with great success [Chang et al. 2013]. In this way, DT has been heralded as a well-suited methodology in encouraging innovation and economic growth [Liedtka 2011]. As a result, it has been introduced in many different organisational settings, such as social innovation, education and management [Cipolla and Moura 2011], [Burdick and Wilis 2011], [Chang et al. 2013]. However, measuring the outcomes produced by the Design Thinking practices is still a challenge [Liedtka 2011]. In addition, the implementation of DT usually requires a change in the organisation culture, the creation of new job positions and new physical spaces – which means cost for organisations [Rauth et al. 2014]. Consequently, convincing managers to introduce DT in an organisation is not an easy task. In order to solve those challenges, it is necessary to gain a better perspective of DT literature to provide to the industry a simple way to understand this interdisciplinary approach.

Chai and Xiao [2012] provided evidence that Design Thinking has been a trending topic in the Design Studies Journal over the last years. As indicated by Elsevier, the Design Studies Journal is one of the most comprehensive and interdisciplinary journals on design research. However, no systematic research effort has been made on aggregating evidence from the Design Studies Journal to understand the evolution of DT from the last ten years. This study aims to extend the results of Chai and Xiao [2012] by analysing the evolution and benefits of the research based on Design Thinking in the Design Studies Journal from 2006 to October 2015. A systematic mapping study [Kitchenham 2010] was performed in order to provide evidence of how the understanding of DT has evolved, suggest important implications for practice and identify research areas for improvement. Mapping Study [Petersen et al. 2008] is an evidence-based approach which central goal is to provide an overview of a research area and identify the quantity and type of research and results available within it. A systematic mapping may be needed for two reasons: firstly, it provides a good introduction analysis to a particular area, and secondly when the academia wants to understand the perspectives on the literature in order to solve research challenges [Petticrew and Roberts 2006]. Overall, 269 papers were found in manual searches, and 42 relevant ones were selected. The result summarizes relevant empirical study data that was used to map gaps and trends

for research and development. Moreover, this paper discusses the relationship between the core challenges and trending topics of the research based on DT in Design Studies. Based on that, this study contributes to the literature by a) providing the first systematic mapping of DT literature in Design Studies from 2006 to October 2015, and b) identifying how the perception of DT has evolved in a range of disciplines. Furthermore, it also offers a practical contribution to the industry by providing a good interdisciplinary introduction of DT.

## 2. Design thinking

Design Thinking is a creative process that uses mechanisms to identify problems and generate innovative solutions [Lockwood 2009]. During DT activities, designers regularly (re)define and/or frame problems, adopt holistic thinking, sketch, draw, and model possible ideas [Goldschmidt and Rodgers 2013]. However, Brown [2009] states that “<design is too important to be left only to designers>”. Studying the way designers work and adopting some design practices could be interesting to organisations because designers have been dealing with open, complex problems for many years [Dorst 2011]. The idea behind this approach is to employ practices that help organisational participants to evaluate fundamental assumptions about the way their organisations function and to thus develop appropriate solutions to problems [Boland and Collopy 2004]. However, a generally accepted definition of DT has yet to emerge, and even the term itself is a subject of controversy among its practitioners and advocates [Liedtka 2011]. Much of the academic literature has focused on developing DT models to serve as a guide to solve problems in different settings [Brown 2008], [Chang et al. 2013], [Storvang et al. 2014]. The table below summarizes some of the existing models.

**Table 1. Design thinking models**

Model	Format	Differences	Focus	Target Public
Brown [2008]	Cyclic	3 phases methodology	To build the solution	Different contexts
Plattner et al. [2010]	Linear	6 phases Curves	To teach students and professionals how to become design thinkers.	Inexperienced teams
Rosensweig [2012]	Pyramid	DT for supporting design as a dynamic capability	To identify how design becomes a dynamic capability	President/CEO in large companies
Chang et al. [2013]	Matrix	Psychology Innovation Matrix	To identify the right Design Thinking path	Managers in large organisations
Storvang et al. [2014]	Spider diagram	Clarification of key drivers for innovation	To measure the design capacity of a company	Managers in micro, small and medium-sized companies

The most well-known DT model was proposed by Brown [2008], and it can be used in different contexts (e.g. social innovation, products, and services). Unlike most researchers, Brown [2008] believes Design Thinking to be a way of thinking rather than a sequence of orderly steps. Based on that, he proposes a cyclic model with three phases that focus on discovering new opportunities and solving problems. Plattner et al. [2010] offer a model with six steps, which are interconnected to others by curves with the objective to point out that each phase might be iterated in loops. This model is particularly well used for training inexperienced teams. Rosensweig [2012] proposes a theoretical model that identifies how DT can help turn design to a dynamic capability for any organisation when its promotion and support shift from a person to a function. Chang et al. [2013] present a new perspective on Design Thinking by introducing findings from psychology to create a new model. The model helps managers to choose a Design Thinking path – three paths are specified in the paper. Storvang et al. [2014] describe a model based on five criteria that measure how well equipped the company is to bring design into play to support its innovation efforts. Although authors have been focusing on developing new models, is still a challenge to convince managers to implement DT models in their organisations, as they generally find it difficult to prove the usefulness of DT [Rauth et al. 2014]. The implementation of DT usually requires a change in the organisation culture, the creation of new job positions and new physical spaces [Rauth

et al. 2014]. Because of that, the use of DT often involves costs to the company, which naturally leads to a demand for evaluating the impact of Design Thinking on the organisation. Therefore, it is important to provide proof of DT's value in order to encourage the managers to acquire the additional resources necessary to implement it.

## 2.1 The increasing importance of design thinking

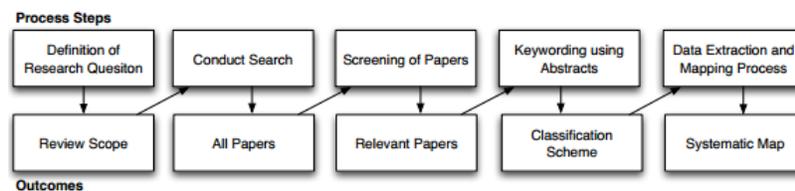
Design Thinking is lauded to present an alternative to typical approaches to organisational problem-solving, which consists of several steps that include defining the problem, generating and testing solutions [Brown 2009]. Due to its importance to problem-solving, DT has been implemented in many different organisational settings. From the perspective of social innovation, many authors have seen the potential of DT as a way to improve the quality of healthcare and public transportation [Cipolla and Moura 2011]. At the same time, the 'new media educators' have been advocating for DT to be taught in universities to help the students to become innovative professionals [Burdick and Willis 2011]. Moreover, it has also been applied to industrial contexts such as small and medium-sized enterprises (SMEs) [Acklin 2010] and large organisations [Chang et al. 2013].

In contrast to traditional management approaches, DT practices are based on learning through experimentation by working closely with the users. Contexts in which there are high uncertainties and ambiguity can benefit from an experimental approach that explores multiple solutions [Liedtka 2011].

In recent years, Design Thinking has gained ground in the industry, especially in the United States [Wong 2009] and Europe [Rauth et al. 2014]. Companies are seeking competitive advantage by leading through innovation. This is because the design of products and services is a major component of business competitiveness, to the extent that many known companies have committed themselves to becoming design leaders [Dunne and Martin 2006]. Dorst [2011] states that DT is intimately linked to organisations by promoting a deeper transformation of the organisation's practices. In light of this, Chang et al. [2013] describe how Apple's decision of adopting an independent Design Thinking team has strongly contributed to the success of iPhone and MacBook. In a more recent work, Storvang et al. [2014] indicate that having a Design Thinking team is tightly related to the success of the Danish companies by creating design awareness among management and staff members. Rosensweig [2012] identified that by using DT as a strategic component, an organisation can exceed the expectation of its stakeholders and advances its assets - the idea is to promote a strong relationship between DT and business. In this way, the literature has perceived that DT practices as a powerful tool to create breakthrough products and promote the success of organisations.

## 3. Research method

This study systematically maps [Arksey and O'Malley 2005] how the understanding of Design Thinking has evolved over the last ten years in the Design Studies Journal publications. In the following figure, it is possible to see the steps this research followed.



**Figure 1. The systematic mapping process [Petersen et al. 2008]**

The research strategy followed the practices for conducting systematic literature reviews [Petticrew and Roberts 2006] as well as the systematic map process [Petersen et al. 2008], [Kitchenham 2010]. It is worthwhile to highlight that the importance and use of systematic map process is increasing [Condori-Fernandez et al. 2009] due to its relevance and potential. As defined by Kitchenham [2010], the main reasons to perform a systematic map process are: a) to avoid unnecessary duplication of effort and error and b) to identify gaps and clusters in a set of primary studies, in order to identify topics and areas to perform more complete systematic reviews. The first step in this process is to define the research

questions, and then conduct the search for relevant papers, screening of papers, keywording of abstracts and data extraction and mapping. As a result, the outcome is the systematic map. In light of this, this study aims to analyse the evolution and benefits of the research based on Design Thinking in the Design Studies Journal from 2006 to October 2015.

### 3.1 Research questions

In this article, the following central research question guided the search: How has the understanding of Design Thinking evolved over the last ten years in the Design Studies Journal? The following specific research questions (RQs) were used to guide the data extraction and synthesis of results:

- RQ1: What research topics are investigated in the area of Design Thinking?
- RQ2: What disciplines have been influenced by Design Thinking over the years?
- RQ3: What are the current challenges in the Design Thinking literature?

### 3.2 Conduct search

*“The primary studies are identified by using search strings on scientific databases or browsing manually through relevant conference proceedings or journal publications”* [Petersen et al. 2008].

The scientific database chosen was the Design Studies Journal because as indicated by its publisher, Elsevier, Design Studies is one of the most important journals to approach the understanding of design from comparisons across all domains of application, including engineering and product design, architectural design and planning, computer artefacts and systems design. Moreover, as other design journals are emerging, Design Studies focuses more than ever, on the aims of the Design Research Society, i.e. on ‘promoting the study of and research into the process of designing in all its many fields’ [Cross 2010]. According to Chai and Xiao [2012], Design Studies provides a relevant representative view of design research. Since the purpose of this paper is to provide an overview of the interdisciplinary research based on DT, the authors believe that the Design Studies Journal is a worthwhile database source.

In order to achieve the goal of this paper, it was performed a manual search using the following keys: “design thinking” OR “design-thinking”.

### 3.3 Screening of papers

Inclusion and exclusion criteria are used to exclude studies that are not relevant to answer the research questions [Arksey and O’Malley 2005]. The selection of relevant papers was performed in two steps: pre-selection and selection. In the pre-selection step, all the papers in which either the keys “design thinking” or “design-thinking” appeared were selected. In the selection step, inclusion and exclusion criteria were applied to the set of papers resulting from the pre-selection step. Criterion for selecting the articles was as follows:

- All papers in which at least one of the keys was quoted twice

The inclusion criterion was chosen due to the fact that papers that quote the strings only once do not address the theme further. Consequently, they were not useful to answer the research questions.

Criterion for not selecting the articles were as follow:

- Keynote speeches, workshop reports and editorials.

Only empirical and theoretical papers were considered because they can provide evidence to answer the research questions of this study. In total, 269 papers were found in the manual conduct search and 42 relevant papers were selected based on the inclusion and exclusion criteria.

### 3.4 Keywording using abstracts

Keywording is a way to reduce the time needed in developing the classification scheme and ensuring that the scheme takes the existing studies into account [Petersen et al. 2008]. Keywording was done in two steps. First, all the abstracts were read in order to identify the themes and research gap. In the cases where the abstracts lack relevant information, the introduction was also studied. Second, the set of keywords were clustered and used to form the following categories table.

**Table 2. Research type facet**

Year of publication	Temporal view of publications
Country	Countries of the authors' affiliations
Themes	The research topics related to DT
Disciplines	The disciplines influenced by DT
Research Gap	The main problem/question

In order to identify research trends as viewed by researchers, an author keyword analysis [Garfield 1990] was performed. Author keywords describe the article's contents and provide information about research topics. Keywords were identified and listed. Similar keywords were grouped together into themes which resulted in the following: design practice, design theory, software design, design education and design cognition. This search strategy was used to ensure we comprehend how the perception of DT has evolved in the design literature.

### 3.5 Data extraction

When having the classification scheme in place, the relevant articles are sorted into the scheme, i.e., the actual data extraction takes place [Petersen et al. 2008]. The data extraction was done in two steps. In the first step, the MindJet Software was used to create a mind map with all the data. The mind map is one of the most practical ways of organizing and visualizing the information collected. Due to the large size of the map, it was necessary to split it up in tables and figure. Since the research gaps, disciplines and themes are essentials to answer the research questions, they were addressed in more detail in the second step. In the second step, a bubble plot was created to correlate the gap, disciplines and themes. According to Petersen et al. [2008], the bubble plot supports analysis better than frequency tables by giving a quicker overview of a field. In this case, the map was used to allow a deeper insight into the gap, themes and disciplines of the selected papers.

## 4. Results

In this section, the result of the mapping study is presented along with the answers to the RQs.

### 4.1 Temporal view of publications

A total of 269 papers were found in manual searches, and 42 relevant papers were selected from 2006 to October 2015. From 2006 to 2011 the number of publications related to DT increased reaching its maximum with six publications in the last three years (2009 - 2011) with six publications per year. However, in 2012 this total fell by 50%. The number of publications in 2013 and 2014 remained a constant of two papers per year, whereas the total reached its maximum again with six publications in 2015. The peaks reached from 2009 to 2011 may be explained by the Design Thinking Research Symposia (DTRS) that was held in London in 2007. Based on that, two workshops were held in the next two years about DT, which may be inspired the researchers to contribute to the discussion with their perspective. The peak in 2015 proves that DT has become increasingly important to academia.

### 4.2 Countries of the authors' affiliations

This study identified a total of 90 authors and 13 different countries. The countries of authors' affiliations were grouped into two periods. The period I corresponds to the first five years (2006 – 2010) and the period II to the last five years (2011 – 2015). A large proportion of articles in Design Studies come from the UK and the USA. However, the number of articles from North America increased in period II, whereas the number of articles from the UK decreased significantly. In addition, the journal has received more articles from other countries in Europe and Oceania from 2011 to 2015. This result proves that DT has been attracting more attention over the world.

### 4.3 The most correlated themes with DT

Table 3 shows the most-related themes with DT in Design Studies from 2006 to 2015 based on an author keyword analysis [Garfield 1990]. The purpose of this analysis is to determine the research topics that

are influenced by DT and understand how they are related. Although one research topic does not necessarily exclude the others, the authors' keywords were very clear regarding which one provided a reasonably picture of the article's subject.

**Table 3. Research topics**

Period	Design Practice	Design Theory	Software Design	Design Education	Design Cognition
I (2006 – 2010)	05	05	01	03	09
II (2011 – 2015)	05	03	04	02	05

It seems that in the first period, the design cognition theme was leading the research projects with nine publications, whereas software design was the least recurring theme with just one publication. In the last five years (II), all the themes had a decrease by 50%, whereas the number of publication relating design and software doubled. Nevertheless, the theme most addressed by the authors remained on cognition design. It will be briefly described how DT influences the research topics.

- Design Practice: from 2006 to 2011 the papers focused on understanding how DT would look like in practice and what benefits it could bring to organisations. In recent years, many studies seek to understand whether managers and engineers should also participate in the Design Thinking activities in order to improve the creation process.
- Design Theory: D has been understood as a new way of “design making”. The papers investigate how DT affects the construction of problems and how they are solved using digital technology. In this way, the term “digital design thinking” was formulated and it has been considered as a new design medium.
- Software Design: the first paper was published in 2010 and aimed to understand how software designers make decisions during the design activities. In recent years, many studies started to investigate how computer-mediated communication could add value to collaborative design.
- Design Education: Design Thinking is considered as one of the most valuable modes of taught. Therefore, researchers are seeking to understand what the nature of DT is and how one can become a design thinker. Initially, the researchers were more preoccupied with discussing how DT could be taught to interior design students. Nowadays, a more variety of disciplines is being included such as architecture and computer science.
- Design Cognition: Many studies attempt to understand the cognitive processes underlying the creative behaviour of human designers. These studies examine the neurological basis of DT and those who exhibit DT traits in order to increase their “problem-finding” behaviour.

#### 4.4 The most correlated disciplines with DT

The purpose of this analysis is to identify which disciplines have been influenced by the DT research. Considering that the aim of the Design Studies Journal is to promote interdisciplinary research, it is not surprising that 13 different disciplines were found (see Table 4).

However, it is remarkable to notice that Design Thinking has influenced disciplines such as Physical Therapy and English. In order to identify the disciplines of the authors, it was considered the affiliation they described in the paper. According to Table 4, the design field has been the discipline that publishes more papers about DT with 23, and it is followed by engineering design with 17 papers. From period I to period II the engineering design and education disciplines had an increase in the number of papers published, which means that DT has demonstrated great potential to solve the challenges in those fields. In addition, the biggest increased in papers published was from the education field that explains why many studies seek to comprehend how one can become a design thinker. In period II, different disciplines rose such as business, English and physics. In fact, this indicates that DT has gained popularity over the years by making contributions to a variety of disciplines.

**Table 4. Disciplines**

Discipline	I (2006 – 2010)	II (2011 -2015)
Engineering	0	6
Design	12	11
Engineering Design	8	9
Architecture	10	5
Philosophy	1	1
Psychology	3	0
Computer Science	8	3
Education	2	4
Human Environmental Studies	2	0
Physical Therapy	1	0
Business	0	2
English	0	1
Physics	0	1

#### 4.5 The research gaps

Table 5 summarises the core challenges in the DT literature in Design Studies over the last ten years. The most relevant gap was selected in each year based on the quantity of authors who support the challenge.

**Table 5. The research gaps**

Code	Year	Challenges	Authors
I	2006	The literature does not fully address the requirement-driven DT for the digital formulation of design problems.	Goldschmidt, G; Smolkov, M.
II	2007	Analysis of the nature of design problems is rarely treated in the literature.	Harfield, S.
III	2008	There is a lack of clarity with respect to the methodological nature and contributions of digital design methods.	Kim, M. J. and Maher, M. L
IV	2009	There is very little research on the neurological basis of design.	Alexiou, K. et al
V	2010	There is still very little scientific understanding of the combination of DT with others disciplines.	Zuo, Q., et al; Tang, A., et al
VI	2011	There has been little agreement on what is the contribution of DT in organisations.	Dorst, K.; Burdick, A., and Willis, H.
VII	2012	Very little attention has been paid to the role of DT, the nature of knowledge, and how it is acquired.	Carmel-Gilfilen, C. and Portillo, M.
VIII	2013	There is no consensus regarding whether many aspects of DT common across different design domains.	Goldschmidt, G., and Rodgers, P. A.
IX	2014	No consistent conclusions concerning the optimal form of inspiration sources to influence the DT process have been drawn.	Cheng, P., Mugge, R., and Schoormans, J. P.
X	2015	How to identify Design Thinkers is still a challenge.	Blizzard, J., et al

Prior research has centred on the analysis of design problems and the contributions of digital design methods in order to improve design performance. From 2010, many studies focused on the relationship

between DT and different contexts such as software companies and universities. Moreover, the question of how DT would fit and contribute to the scientific sphere in terms of innovation has also been central in the literature. Although a lot of work has been published about how DT can contribute to other fields, the nature of DT and how one become a design thinker remains open to debate. This means that the importance of being a design thinker is widely recognised; therefore, it is essential to understand the behaviour of designers in order to identify DT traits.

#### 4.6 The mapping

Figure 2 illustrates a unified mapping with two associations: the relationship between research gaps and research topics, and the relationship between the types of disciplines and research topics.

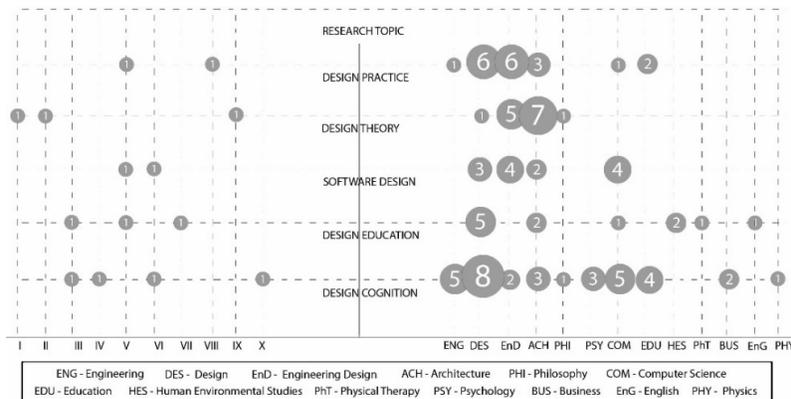


Figure 2. Mapping of research topics, gaps and disciplines

Both disciplines and research topics are represented by codes (see Table 5). The size of the circle indicates how many papers were identified for each relationship, and the number in the centre symbolises the sum of papers in the specific discipline/research gap.

It seems that the design and architecture field are the only one to pursue research in all the five topics. Although many efforts are made to understand all the research topics, the architecture field is more concerned with the relationship between DT and design theory. In light of this, many studies seek to understand how the problems are solved and constructed by designers in order to create a better way to frame architectural design problems. Moreover, it is interesting to notice that computer science researchers express more concern with design cognition than software design. A possible explanation for this might be that software organisations are more interested in understanding how one can become a design thinker and how DT can be integrated into organisational practices as a way to create better opportunities for problem-solving. Regarding design practice, the engineering design field along with design are the ones to develop more research on this topic. In this way, many engineering studies seek to understand the neurological basis of design by using a functional magnetic resonance imaging in designers while performing design and problem-solving tasks. The less expressive topics in the DT literature such as English and physical therapy have published studies only in the education field. The data indicates that different types of professionals seek to have a good knowledge of DT.

#### 5. Discussion

This study aimed to identify how the perception of DT has evolved among a variety of disciplines over the last ten years in the Design Studies Journal. In this section, we summarised the answers to the research questions as well as the implications for research and practice of Design Thinking.

The first question intended to understand the research topics related to DT. The following research topics were found: design cognition, design practice, design theory, design education and software design. The findings show that design cognition is the most addressed research topic; however, the research on software design had a considerable growth in the total of papers published and it is more likely to continue on the increase. The purpose of the second question was to discover the disciplines influenced by DT. From the 13 disciplines found, the design area was identified as the one that publishes more

papers related to DT, and it has been followed by engineering design. Although the education topic had the greatest increase in the last five years, different disciplines also demonstrated their interest in DT such as business, English and physics. The third question aimed to identify the challenges in the DT literature such as “We still don’t know how to identify Design Thinkers”. This gap, in particular, has been addressed since 2009, and it remains open to debate.

The first finding to emerge from the analysis is that DT has gained popularity and become more influential over the years by making contributions to a variety of disciplines. In general, the findings suggest that current research on engineering, design and education has focused on the design cognition and the great challenge of DT which is how to become a design thinker. It is likely that not only academia but also industry will benefit if the challenge is solved. Meanwhile, in terms of practical uses, Design Thinking is still not mature, and that introduction of its process may not have the desired results. Therefore, this research recommends that more studies must be conducted in order to understand the real nature of DT and how it can be taught and applied in different settings. Furthermore, future research should focus on proving the usefulness of DT.

## 6. Conclusion

This paper presented a systematic mapping study on the influence of DT in the Design Studies Journal from 2006 to October 2015. From 269 papers found in manual searches, 42 relevant papers were selected. It was investigated how the perception of DT has evolved in the last ten years, the core themes, and current challenges. Moreover, all the disciplines that have benefitted from DT and future trends in the literature were also identified. In regard to the geographic location of the authors, 13 different countries were found. Although DT has gained popularity, it may be necessary to more countries to be involved in order to take into account the cultural and social differences that may have an effect on the research findings. Based on that, one limitation of this study is not trying to correlate the cultural aspects of the authors with the research topics, gaps, and disciplines of the selected papers. In addition, the most common limitation in a systematic mapping study is possible biases and inaccuracies in the data extraction. In order to avoid that, the research method was based on well-established guidelines. This research concludes that DT has potential to be applied in different settings (university, organisations, etc.). The findings provide a deep understanding of past research in DT and uncovered many challenges that might be addressed in the future. Based on that, this study contributes to the literature by a) providing the first systematic mapping of DT literature on Design Studies from 2006 to October 2015, and b) identifying how the perception of DT has evolved in a variety of disciplines. Moreover, it also offers a practical contribution to the industry by providing an excellent interdisciplinary introduction of Design Thinking.

## Acknowledgement

This research was undertaken with support from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPQ) – Brazil.

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Danielly Oliveira De Paula, PhD Student  
 National University of Ireland, Galway, College of Engineering & Informatics  
 9A Willow Park, H91 F469 Galway City, Ireland  
 Email: d.ferreiraoliveiradepaula1@nuigalway.ie