Mapping the Characteristics of Design Research in Social Sciences

Dayoung Lee[1], Hyunju Lee[2*]

[1]Department of Visual Communication Design, Professor, Digital Seoul Culture Arts University, Seoul, Korea
[2]Department of Human Environment and Design, Professor, Yonsei University, Seoul, Korea

Abstract

Background This study aims to identify the characteristics of design studies in disciplines other than design science. Design has grown with industry and developed through close relationships with other disciplines. The scope, method, and purpose of design are not fixed, and design scholars can easily participate in research in other fields. In this context, it is important to understand the nature of design research in other disciplines and how design is used in other disciplines.

Methods Through a literature review, we developed a framework for understanding the cross-disciplinary use of design, the classification of design research, and the meaning of design terms. We used this framework to analyze what types of studies on design have been conducted in the social sciences and what type of design they were used for. We selected 443 design research papers out of more than 8,000 articles published from 2004 to 2017, and then qualitatively coded their characteristics through content analysis.

Results The framework provides visibility into connectivity and patternsand shows the relationship between the type of design study and the meaning of the design term.While design research in the social science field is used in various design terms at various levels, applied research into design appeared the most frequent in social science.

Conclusions Efforts to understand the characteristics of design studies in other disciplines will contribute to the development of the design field and lay a foundation for future interdisciplinary research. Despite its value as exploratory reconnaissance research, this study had empirical limitations related to the temporal and thematic scope of published articles.

Keywords Framework, Interdisciplinary, Content Analysis, Qualitative Coding

This study was modified and developed from the Ph.D. thesis of the first author.

*Corresponding author: Hyunju Lee (hyunju@yonsei.ac.kr)

Citation: Lee, D., & Lee, H. (2019). Mapping the Characteristics of Design Research in Social Sciences. *Archives of Design Research, 32*(4), 39-51.

http://dx.doi.org/10.15187/adr.2019.11.32.4.39

Received : May. 28. 2019 ; **Reviewed :** Sep. 23. 2019 ; **Accepted :** Oct. 24. 2019
pISSN 1226-8046 **eISSN** 2288-2987

Copyright : This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/3.0/), which permits unrestricted educational and non-commercial use, provided the original work is properly cited.

1. Introduction

As society has become more complex, social problems have occurred more broadly across the globe. These problems have been termed "wicked problems" by Professor Horst Rittel (1972) in the science of design. Wicked problems are complex problems that an individual, group, or organization cannot solve easily alone. As well, scholastic efforts to solve wicked problems require an understanding that extends beyond an independent discipline. Thus, efforts to address these problems can be cross-disciplinary (viewing one discipline from the perspective of another), multidisciplinary (people from different disciplines working together, each drawing on their disciplinary knowledge), interdisciplinary (integrating knowledge and methods from different disciplines, using a real synthesis of approaches), and trans-disciplinary (creating a unity of intellectual frameworks beyond the disciplinary perspectives) (Stember, 1991; Stock & Burton, 2011; Zeigler, 1990).

Design has been considered a practical way to solve problems, and an area that has high feasibility for cross-, multi-, inter-, and trans-disciplinary research. The scope, methods, and objectives of design are not fixed. These components change over time and vary with the economic and cultural context. Buchanan (2001), a design scientist, contended that people involved in design research are easily drawn into research in other fields. The design community consists of people who can easily conduct many different types of research. Despite the growing application of design across disciplines, no study has explored the status, nature, and characteristics of design research in other disciplines. Exploring design research requires an understanding of design itself. Design can be viewed as a discrete activity or as a total process in terms of its tangible outcomes. It can be viewed as a management function, a cultural phenomenon, and/or an industry in its own right. It is a means of adding value and an instrument for social and political change. Its definition depends on individual, collective, and organizational understanding, and it changes over time across cultures and countries. Design is conceptualized in various ways from various perspectives. Given this multi-dimensional, multi-faceted meaning of design, it is important to understand how disciplines other than design science define what design is.

Building a common understanding of key concepts can enhance mutual communication across design-related disciplinary boundaries. Han & Kyung (2011) found major impediments to interdisciplinary research in terms of cognition and communication, so design research may help identify philosophical disparities (chiefly, differences in viewpoints on design) and communication difficulties (chiefly, differences in the definitions of design) that hinder interdisciplinary research on design. So far, little research has explored these two formidable barriers (philosophical disparities and communication difficulties) to interdisciplinary design research. Indeed, there is a visible dearth of such studies. Thus, relevant empirical studies are needed to fill this data gap with evidence. A considerable number of conceptual studies have discussed the nature of design research within design science (e.g. Laurel, 2003; Sato, 2004; Fallman, 2007; Poggenpohl and Satō, 2009; Koskinen et al, 2011), but no studies have addressed design-related research in disciplines other than design science. Despite a growing recognition of design as a pivotal element of interdisciplinary and trans-disciplinary research (Kim, 2003; Koh, 2010; Choi, 2012; Kim, 2013; Park and Kim, 2013), an understanding of the nature of design-related research in other disciplines has not been developed. There is a wide gap between an array of interdisciplinary reflections within design science and the lack of interdisciplinary understanding across multiple disciplines. A relevant study should bridge this research gap.

To that end, we sought to characterize design research in other disciplines by associating the type of design research with the design used in each type, and to suggest a framework to map the characteristics of design research. The framework is expected to illuminate the overall patterns underlying design research in other disciplines, as these patterns can be identified through the nexus between research types and design definitions. These two tasks were addressed through taxonomies and frameworks, which were newly developed on the basis of much-cited classifications and categorizations in the design literature. To complete these tasks, we conducted empirical research to confirm the applicability of the framework, focusing on articles published in Korean social science journals. The results of taxonomization were coded

qualitatively through content analysis.

The remainder of this article is structured into the following six sections. Section 2 derives existing classifications of design research from previous literature. Section 3 discusses multiple definitions of design. Section 4 suggests the framework for addressing typologies of design research. Section 5 describes the whole process of data collection and analysis through empirical research. Section 6 reports the results of framework application. Finally, section 7 summarizes and interprets the findings.

2. The classifications of design research

Poggenpohl & Satō (2009) described two types of design research: one type addresses practical development, and the other is a component of academic research (p 27). The current study sheds light on the latter—design research with an academic focus. Design research may contribute to theories, methods, principles, and tools that become resources for future cycles of knowledge development and/or practical applications of knowledge (Satō, 2004: p 218). This perspective is congruent with the purpose of the current study, which was to identify implications for interdisciplinary research related to design.

Table 1 Classifications of design research

Studies	Classification
Sato (2004), Poggenpohl & Satō (2009)	Theoretical research
	Methodological research
	Case–based research
	Experimental/empirical research
Buchanan (2001), Friedman (2003)	Basic research
	Applied research
	Clinical research
Frayling (1994), Forlizzi et al. (2009), Frankel & Racine (2010)	Research into (about) design
	Research through design
	Research for design

Satō (2004) suggested classifying design research into theoretical, methodological, and empirical/experimental research. According to Sato, theoretical research on design seeks to create a new theory, theoretical framework, or theoretical insight. A theory is a consistent system of propositions that explain a focal topic with formal and abstract terms. It is logically developed through facts established by deduction and other theories. Theories may have different meanings in different disciplines.

Satō (2004) also added one more type of design research to these three types: case-based research. This type of design research uses real cases from the past as a source of data or creates a case for simultaneous data inquiry with or without a research intention embedded in it. Case-based research provides a basis for inductive generation of hypotheses or validation of proposed hypotheses while the case project achieves its own objectives. Case studies of design fall into this category.

Buchanan (2001) classified design research into three categories according to the type of problem addressed: basic research, applied research, and clinical research.

Basic research encompasses processes of data collection through experiments for examination, improvement, and development of well-established theories and principles. Most of the time, basic research does not directly lead to economic benefits. Starting from a place of intellectual curiosity, basic research strives to develop an understanding of fundamental principles explaining phenomena and to acquire new knowledge. Thus, this type of research addresses fundamental issues and problems in understanding the existing principles that govern and explain phenomena (Buchanan, 2001: p 18). This type of research is rare among design studies, compared to applied and clinical research.

Applied research in design is more common today than several decades ago. This type of research is

overall well-funded and popular in such disciplines as engineering, computer science, and business administration. A common trait of applied research in design is the attempt to gather from many individual cases a hypothesis or hypotheses that may explain how the design of a class of products takes place, the kind of reasoning that is effective in the design for that class, and so forth (Buchanan, 2001: p 19). Its goal is not to discover first principles of explanation but rather to discover principles or even rules-of-thumb that account for a class of phenomena.

Clinical research is, as the name suggests, directed toward an individual case. Many forms of clinical research are common in the design community, and they play an important role in design practice, as well as in design education. Clinical research addresses design problems that require action. To solve a certain design problem, it is essential to gather any information or understanding that may be relevant to a solution. Educators teach their students how to find such information and how to organize it as part of the design process, leading to a certain design solution suited to an imaginary or real client (Buchanan, 2001: p 17). Clinical research is important for organized research activities and programs.

While the classification of Frayling (1994) is discourse-based, the study of Forlizzi et al. (2009) describes three types of design research identified in their interviews and echoed by others in the community: research on/about design, research through design, and research for design. The results of their interviews have provided evidence for the existence of a slowly growing but recognizable body of design theory resulting from design research. Their discussion has helped to clarify the types of design research, with illustrations and examples of design theory. Three interconnected areas of design research and theory have been identified.

Research on (or about) design has a research focus on the human activity of design, producing theory that describes the process of design. Forlizzi et al. (2009) found that research on design was the most widely recognized type of design theory among interview participants. This kind of research purports to develop "a detailed and unified understanding of the human activity of design or of design-related activities such as creativity" (Forlizzi et al., 2009: p 2892). Research on design is more about understanding the human activity of design than in generating knowledge specifically intended to improve the practice of design. This kind of research may address the role of the designer and other stakeholders in the design process. This point is aligned with the focus of the current study.

Research through design is "a research approach that employs the design process as a method of inquiry on the near future, and that can produce theories in the area of research for design" (Forlizzi et al., 2009: p 2892). However, it is difficult to formulate design activities as they enter into the process of research. Although design activity is an important component of research and development (Hengeveld et al., 2016: p 331), it can be difficult to express in writing (Forlizzi et al., 2009; Bardzell & Bardzell, 2011; Hengeveld et al., 2016). Recently, 'disciplinary anxieties' have been discussed by the HCI (Bardzell & Bardzell, 2011; Bowers, 2012; Hengeveld et al., 2016).

This type of research leverages the design process of repeated problem reframing as a method of scholarly inquiry. There are two critical approaches to this type of research, allowing researchers to engage with wicked problems (Rittel & Webber, 1973) and to become active builders of possible futures (Forlizzi et al., 2009: p 2894).

Research for design has "a theoretical outcome of many different activities that provides designers with theories they can apply to improve their practice of design" (Forlizzi et al., 2009: p 2892). This type of research functions as a catchall for several different kinds of theory that were produced with the intention of being applied in the practice of design. Main forms of this type encompass conceptual frameworks, guiding philosophies, design implications arising from the investigation of people and contexts, and design implications arising from the analysis of designed artifacts (Forlizzi et al., 2009: p 2892).

3. The definition of design in design research

The framework for analyzing the definitions of design terms is based on Cooper & Press (1995) and Love (2000). Cooper and Press (1995), in their renowned book The Design Agenda, presented six perspectives on design: design as art, a creative act, problem solving, an industry, a process, and a family of professions. In addition to Cooper and Press (1995), a framework for analyzing design definitions across disciplines should incorporate Love's (2000) abstract levels of design. Love (2000) suggested a meta-theoretical structure with 10 levels as a basis to categorize theoretical and abstract concepts of design research: (1) ontology of design; (2) epistemology of design theory and the theories of objects; (3) general design theories; (4) theories about the internal processes of designers and collaboration; (5) design process structure; (6) design methods; (7) mechanisms of choice; (8) behavior of elements; (9) description of objects; and (10) direct perception of realities.

Citing Karl Popper's (1976) three entities in a co-dependent hierarchy, Love (2000: p 301) considered theories and concepts as abstractions. The meta-theoretical taxonomy manifests the three levels of abstraction in a hierarchical form. Popper addressed the problem of theoretical confusion between: world 1 (physical and material objects); world 2 (the subjective world containing minds and their contents); and world 3 (the objective world of theories, knowledge, and problems). The highest level of abstraction is the world of beliefs and values associated with fundamental issues of existence. Thus, this level is concerned with human values, assumptions about existence, and the implications of those assumptions. By contrast, world 1 mirrors the direct perception of reality and includes an individual's direct, sensual interaction with the world. In the lowest level of abstraction, an individual acquires information through his or her perceptive senses. The intermediate world, everyday abstractions, lies between "direct perceptions of reality" and "beliefs about what is fundamental about existence" (Love 2000: p 304).

Love (2000) argued that the meta-theoretical structure is conducive to design theory by providing a simple solution to problems of confusion and conflation of the concepts, theories, and terminology of design research. Researchers could take a meta-theoretical perspective, use a critical framework for analysis, and then create a structure that enables elements of different theories and concepts to be situated relative to one other. Using a meta-theoretical structure based on levels of abstraction can enable classification, which is hierarchical and relatively independent of the domain-based meanings associated with each theoretical element. This method offers a straightforward way to clarify and externalize hidden dependencies between abstractions in design theory (Love, 2000: p 304).

This framework classified design definitions into broad and specific categories. The broad categorization includes philosophical matters, design process, and objects (Love, 2000) and the meanings of aesthetics, problem solving, and profession (Jang, 2011). Table 2 is the template for data analysis of design definitions.

Table 2 Cross tabulation of design meaning

		Philosophical matters			Design process				Objects		Direct Perception
		Ontology	Epistemology	General theory	Internal collaboration	Process structure	Design method	Choice mechanism	Element behavior	Object description	
Art	Art										
	Creative activity										
Problem solving	Problem solving										
	Industry										
	Process										
Profession	Profession										

Using only a single system of classification for semantic interpretation of design can be limiting, so a unidimensional view should be augmented with other classifications in abstract dimensions. For example, aesthetics is integral to the disciplines of art and philosophy, and it is also a basic condition of design. Design and aesthetics are indispensable. Aesthetics serves as a catalyst from aspiration to design and contributes to the achievement of commercial success (Wagner, 2015: p 77–78). The term "aesthetics" has various connotations. It indicates beauty perceived from the overall aura of a designed object (Seo & Hong, 2016: p 89–90) and emotion perceived from the appearance of an object in use and expressed from its visual information (Jeong & Lee, 2006: p 375). Immanuel Kant (1987) wrote in The Critique of Judgment (Kritik der Urteilskraft, originally published in 1790), that objective perception makes one feel an object beautiful or not. In sum, a discussion of aesthetics overarches emotion simply felt from appearance, beauty felt from overall ambience, and even art philosophy.

The interpretation of aesthetics is subjective and inevitably differs among individuals. A person could interpret aesthetics as a partial impression or overall aura of a designed object (the sense of the object), as emotion perceived (emotion about an object), or as a philosophical concept beyond the object itself.

The reason why many scholars have fallen short in the classification of design is that their work has relied upon a single dimension of classification. Thus, the current study uses a combination approach based on the work of Cooper & Press (1995) and Love (2000) to better conceptualize the definition of design. Such a multi-dimensional analysis is required to explore the meanings of design terms used in other disciplines, as these disciplines lack common classifications arising from the accumulated experience that design communities have.

4. Building the framework to characterize design research

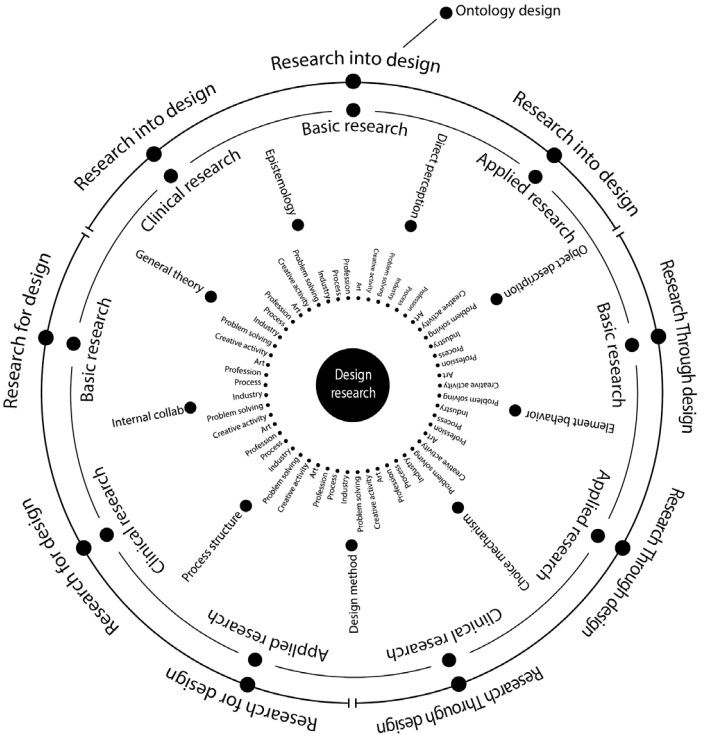

Figure 1 Building a framework

Spatial models that illustrate the relationships among words are representative of meaning (Barnett & Woelfel, 1988), so a deep understanding of the characteristics of design research requires identifying the connections between the types of design research and the definitions of design terms used in the research, followed by analysis of those connections. The framework used in the current study allows for exploration of the characteristics of design research from multiple perspectives by identifying the patterns between the types of design research and design definitions (Figures 1,2). Thus, this framework helps identify an overall pattern. Ontology is considered separately because it is not part of the classification of design definitions. By this framework, characteristics of design research in disciplines other than design science can be categorized according to the research type and design definition.

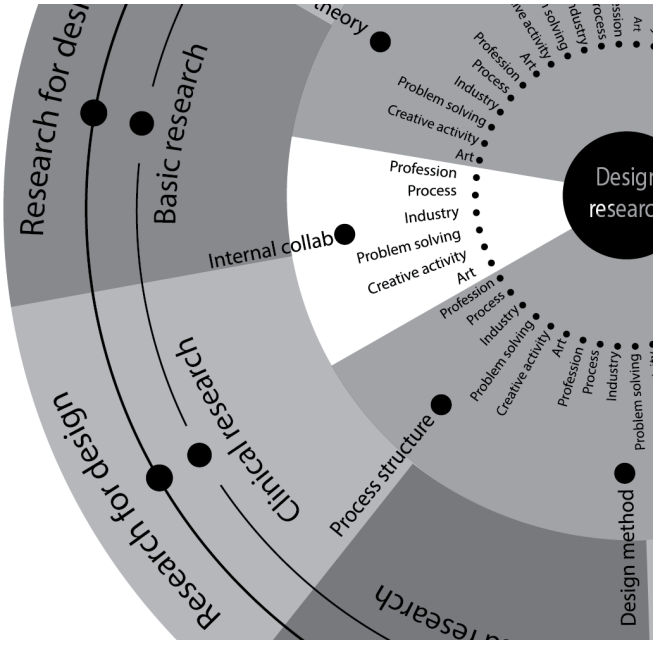

Figure 2 The details of the framework

The two taxonomies of design research (research into/through/for design and basic/applied/clinical research) and the two taxonomies of design definitions (Cooper & Press's six categories and Love's ten categories) are juxtaposed. These four dimensions constitute a framework made up of two concentric circles. The taxonomy of research into/through/for design is the outer circle, while the taxonomy of four-level design definitions is the inner circle (Figure 2).

The results of the analysis (qualitative coding based on the content analysis of design research articles) are illustrated with the following rules. Any single article can be categorized into the two taxonomies of research type and the two taxonomies of design definitions. The four results are connected with curved lines in the framework. A single dot indicates a result of categorization. A curved line that connects two dots should have a mild curve to create a regular pattern.

A collection of mildly curved lines becomes a petal, and a collection of petals becomes a flower. These curved connections make it easy to identify specific patterns. In contrast, it is hard to derive specific patterns from the numeric distribution in a cross-tabulation matrix. The concentric circles and petal framework facilitate understanding of the association between design research types and design definitions, as well as the overall pattern of the association.

The central part of the circle lists keywords describing the connection. The inner petal indicates the definitions of design terms, and the middle point of each petal indicates the levels of design terms. This framework allows visualization of the patterns underlying semantic classification (9 * 6 = 54 categories). A fully blossomed flower with a greater number of visible petals requires an abundance of design research

evenly distributed across multiple definitions and levels. The outer circle surrounding the flower indicates the types of design research. Nine types (3 * 3) are linked with the semantic classification of design terms. While the variety of design terms helps clarify the petals, the overall balance of the whole flower depends on the variety of design research types.

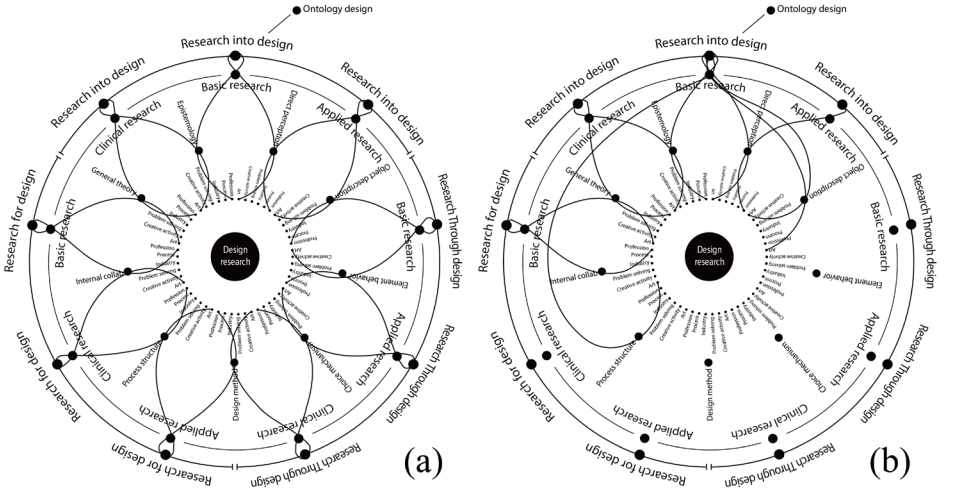

Figure 3 Shaping a complete corolla with all nine petals: (a) complete corolla and (b) incomplete corolla

5. Method for data collection

Data were gathered by using the keywords and titles of design papers published in journals from 2004 to 2017. We used quantitative analysis to narrow the search to the social sciences discipline. There were many studies related to design in the fields of engineering, arts and physical education, social science, natural science, compound science, agricultural and marine science, humanities, and medicine. Among them, the social science field had the widest distribution of design studies and homogeneity and heterogeneity among disciplines within the field. The social science field includes both traditional disciplines, such as law, politics, and education, and applied sciences, such as business administration and tourism. Therefore, we expected this field to encompass a wide variety of characteristics of design research.

In order to collect the data on design research, we employed qualitative coding through content analysis. We identified design-related words, collected papers that included design-related words, extracted sample papers of design research, and performed qualitative coding through content analysis with various goals. From a total of 8,000 papers, 443 were used for qualitative coding through content analysis. In qualitative coding, three professional coders each conducted about a third of the survey, and their data were recorded and post-interviewed.

6. The results of the framework–based analysis

Figure 4 illustrates the results of exploring design research types and definitions in the social science field. It illustrates that design research in the social science field includes various uses of design terms. Applied research is the major type of design research in the social science field.

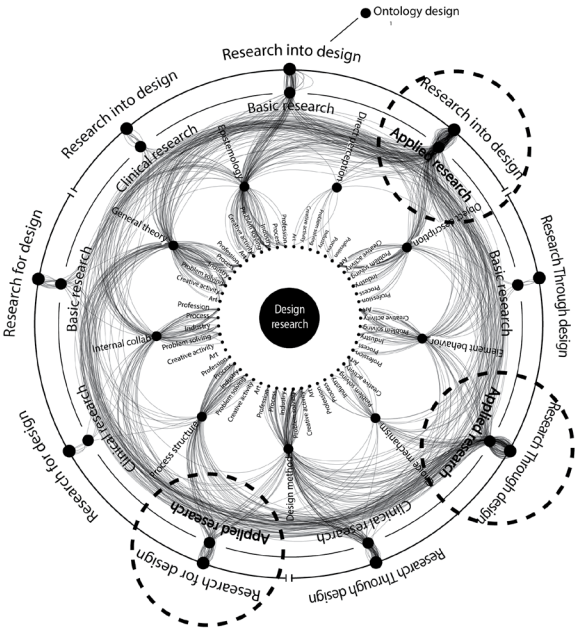

Figure 4 Framework–applied mapping of design research in social sciences

In the social science field, most design research can be categorized as applied research, whether it is research into design, through design, or for design. Applied research into design is the mainstream type of design research in the social science field. In research into design, thicker connections in the upper left and upper right sides of the framework-applied mapping indicate the existence of many articles in the design term categories of philosophy and object (Figure 5). Research through design shows the connection between the philosophical category and general theory in the upper left part, and the connection between the philosophical category and design method in the middle bottom part. There is little research for design, within which the philosophical category is connected with epistemology.

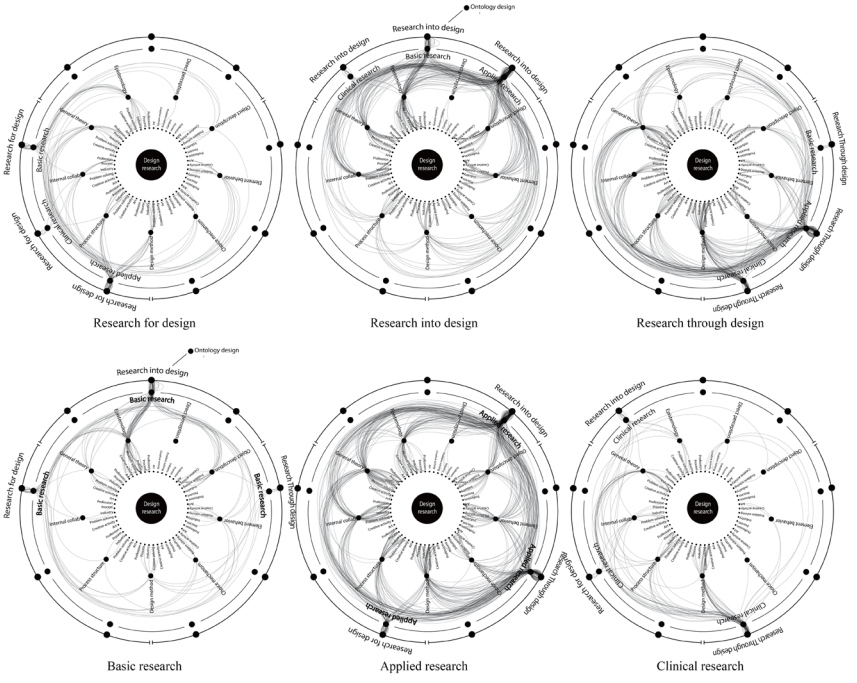

Figure 5 Framework–applied mapping of design research types

Figure 6 presents the results of mapping design definitions from the four levels. The design levels were significantly associated with design definitions. Findings of the framework-based mapping can be summarized as follows.

- Epistemology level (philosophy) — research into design — indicating an industry
- General theory level (philosophy) — all kinds of research types — problem solving — indicating a profession
- Internal collaboration level (philosophy) — applied research in various ways
- Process structure level (process) — indicating problem solving
- Design method level (process) — research through design
- Element behavior level (object) — indicating art
- Object description level (object) — indicating art — applied into design
- Direct perception level

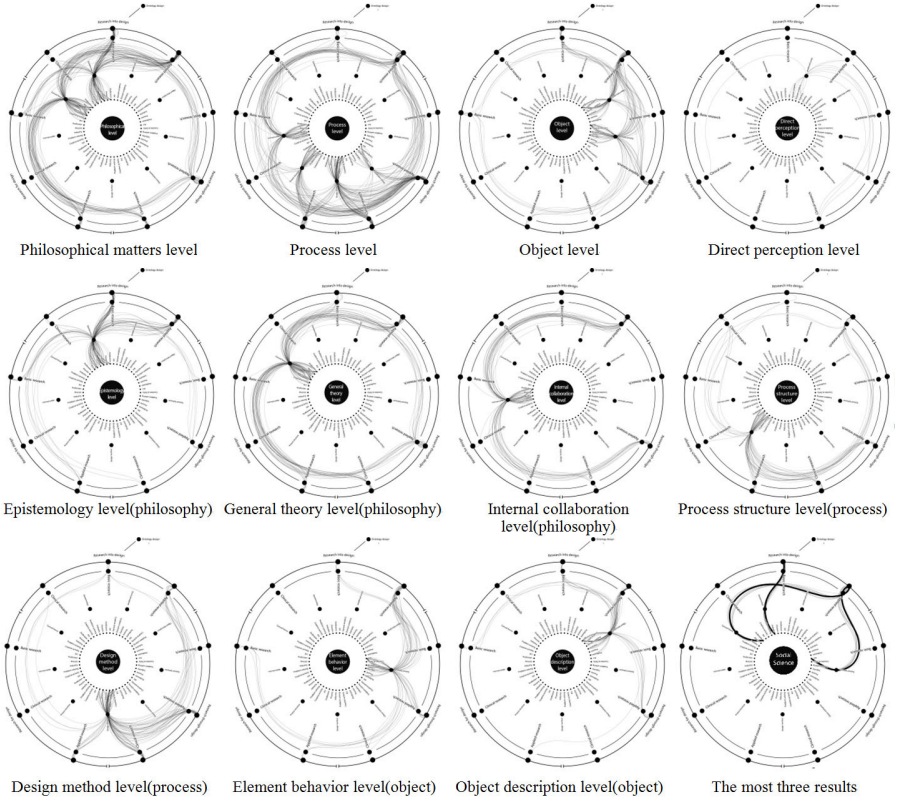

Figure 6 Comparison in main authors between art & sports and social sciences: (a) main authors in art and sports and (b) main authors in social sciences

The mainstream group was also identified.

- General theory level — indicating a family of professions — applied research into design
- Epistemology level — indicating an industry — basic research into design
- Elements behavior level — indicating art — applied research into design

The framework-applied mapping allows identification of patterns within design research articles beyond the characteristics of mainstream design research. How design terms are used in different levels and types of design research requires further discussion.

First, design definitions at the philosophical level were used in various ways. Design research at the philosophical level appeared in basic research into design, applied research into design, applied research

through design, clinical research through design, basic research for design, and applied research for design. Second, specific categories within the process level showed large deviations in design definitions. Many articles in the choice mechanism level reflected design as art, and fell into the category of applied research through design. Research into the process structure level, which belongs to the category of process, appeared in various areas. Research into the internal collaboration level mainly reflected design as problem solving and as a profession. Research into the process level appeared across all types of design research but especially in applied research. Third, both object description and element behavior of the object chiefly regarded design as art. Most research at the object level was characterized as applied research into design. Finally, there were only a few articles at the level of direct perception of reality, so it was not possible to identify a particular pattern.

6. 1. Comparison with Forlizzi et al. (2009)

Forlizzi et al. (2009) conducted a study on the design community and argued that "design research is alive and well, and is recognized by the design community." They suggested that the design community's recognition of design research should be analyzed. For the current study, the authorship of social science articles by design scientists can be considered a proxy measure of such recognition. If the main authors of social science articles are from the design community, then those studies should be categorized as research by the design community, not research by members of disciplines other than design science.

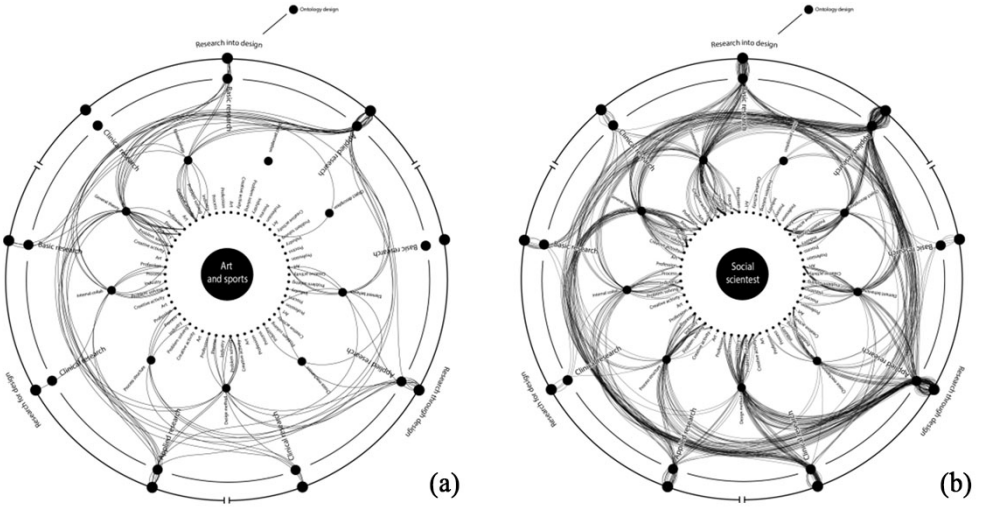

Figure7 Comparison in main authors between art & sports and social sciences: (a) main authors in art and sports and (b) main authors in social sciences

Most of the main authors of the articles investigated for the current study were affiliated with the social science field, not with design science. Social scientists, rather than design scientists, conducted design research in the social science field. Overall, design research articles authored (main author) by design scientists and those authored (main author) by social scientists did not differ strongly in research type. However, design scientists chiefly used design terms at the philosophical level while social scientists used them at the philosophical level and at the object and process levels.

7. Conclusion

This study suggested the visualizing framework that helps compare how design is used across disciplines. The visualizing framework shows the relationship between research characteristcs of journal articles sampled and contextual meanings of the word design in those articles. Despite the guessable finding that most of design-related research is applied research, the study of design as a discipline was demonstrated as a practice-centered discipline enabling research collaboration with other diverse domains.

A cross-disciplinary difference within social sciences is found, and this find can be considered the first step to understand the characteristics of discipline-specific collaboration on design-related research. This study explored how different and even disparate characteristics and traits of design research vary across disciplines within the social science field, thereby exploring possibilities for interdisciplinary research related to design. The discussion may help address philosophical and communication barriers to design-centered, design-applied, or design-used research across disciplines. This study also contributes to the development of a sense of the interdisciplinary potential for the term “design.”

However, this study had some limitations. It took a long time analyze the qualitative content in order to interpret the meaning of design in different articles. There is a need to find ways to gather data more quickly in the future. Another limitation was the focus on academic terms. In many papers, the term 'design' was used in both an academic and a lay sense. To more accurately explore the characteristics of design terms in other disciplines, it is necessary to compare generic terms with academic terms.

References

1. Barnett, G. A., & Woelfel, J. (eds.). (1988). *Readings in the Galileo System: Theory, Methods and Applications*. Kendall Hunt Publishing Company.
2. Bowers, J. (2012, June). The logic of annotated portfolios: Communicating the value of'research through design'. In *Proceedings of the Designing Interactive Systems Conference* (pp. 68–77). ACM.
3. Buchanan, R. (2001). Design research and the new learning. *Design Issues, 17*(4), 3–23.
4. Cooper, R., and Press, M. (1995). *The Design Agenda: A Guide to Successful Design Management*. New York: John Wiley & Sons Ltd.
5. Fallman, D. (2007.) Why research-oriented design isn’ t design-oriented research: On the tensions between design and research in an implicit design discipline. *Knowledge Technology & Policy, 20*, 193–200.
6. Forlizzi, J., Zimmerman, J., & Stolterman, E. (2009). From design research to theory: Evidence of a maturing field. In *Proceedings of International Association of Societies of Design Research Conference*.
7. Frankel, L., & Racine, M. (2010, July). The complex field of research: For design, through design, and about design. In *Proceedings of the Design Research Society (DRS) International Conference* (No. 043).
8. Frayling, C. (1994). Research in art and design. R*oyal College of Art Research Papers, 1*(1), 1–5.
9. Friedman, K. (2003). Theory construction in design research: criteria: approaches, and methods. *Design Studies, 24*(6), 507–522.
10. Han, S., & Kyung, J. (2011), Empirical analysis for promotion of integrated research: Focused on the difference of recognition between all disciplines. *The Korea Association for Policy Studies, 20*(1), 151–179. [Written in Korean]
11. Hengeveld, B., Frens, J., & Deckers, E. (2016). Artefact matters. *The Design Journal, 19*(2), 323–337.
12. Jang, Y. (2011). The study on the ambiguity of design management and its meaning-structure: Focused on meaning of design. *Journal of Digital Design, 11*(4), 369–378. [Written in Korean]
13. Jeong, S., & Lee, G. (2006), The effects of the usability of products on user's emotions. *Archives of Design Research, 19*(5), 373–382. [Written in Korean]

14. Kant, I. (1987). *Critique of Judgment*. Hackett Publishing.
15. Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., Wensveen, S. (2011). *Design Research through Practice: From the Lab, Field, and Showroom*. Morgan Kaufmann.
16. Laurel, B. (ed.) (2003). *Design Research: Methods and Perspectives*. MIT Press.
17. Love, T. (2000). Philosophy of design: A meta-theoretical structure for design theory. *Design Studies, 21*(3), 293–313.
18. Poggenpohl, S. H., & Satō, K. (eds.). (2009). *Design Integrations: Research and Collaboration*. Intellect Books.
19. Popper, K. (1976). *Unended Quest: An Intellectual Autobiography*. La Salle, IL: Open Court Publishing.
20. Rittel, H. W. (1972). On the planning crisis: Systems analysis of the first and second generations. *BedriftsØkonomen, 8*, 390–396.
21. Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155–169.
22. Satō, K. (2004). Perspectives of design research: In design: Collective views for forming the foundation of design research. *Visible Language, 38*(2), 218–237.
23. Seo, H., & Hong, J. (2016). Design similarity judgment tools applying the aesthetic elements scale. *Journal of Integrated Design Research, 15*(3), 85–94. [Written in Korean]
24. Stember, M. (1991). Advancing the social sciences through the interdisciplinary enterprise. *The Social Science Journal, 28*(1), 1–14.
25. Stock, P., & Burton, R. J. (2011). Defining terms for integrated (multi-inter-trans-disciplinary) sustainability research. *Sustainability, 3*(8), 1090–1113.
26. Wagner, F. (2015). *The Value of Design*. Wirkung und Wert von Design im 21, Jahrhundert, Mainz: Verlag Hermann Schmidt.
27. Zeigler, E. F. (1990). Don't forget the profession when choosing a name. In *The Evolving Undergraduate Major* (pp. 67–77), Champaign, IL: Human Kinetics.