กรอบการคิดเชิงออกแบบนอกขอบเขตวิชาชีพด้านการออกแบบ: การวิเคราะห์การนำการคิดเชิงออกแบบไปปฏิบัติ

A Framework for Design Thinking Outside the Design Profession: An Analysis of Design Thinking Implementations

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Abstract

Over the past decade, the term “design thinking” has received increasing attention in a wide range of contexts and has become increasingly familiar beyond the professional design arena. Exploration of potential cross-boundary engagements and the role of design as an agent of change for both innovation and social transformation are two main mechanisms underlying the burgeoning discussion of design thinking in areas outside the design profession. This study provides an insight into the implementation of a design-thinking approach in non-designerly contexts. To investigate how design thinking is understood and applied in relation to non-designerly thinking, an analysis was undertaken of 345 articles from the Scopus database between 2002 and 2017 that included “design thinking” as a keyword. It was found that design thinking serves as a mechanism that enables and promotes innovation and social transformation. The results show that design thinking can foster new approaches to innovation as well as complex and persistent social problems through a framework of co-creation, systemic thinking, abductive reasoning, and iteration. The findings reveal that initiatives using design-thinking approaches can deliver positive outcomes in the fields of business management, social innovation, and education.

Keywords
Design Thinking
Co-Creation
Systemic Thinking
Abductive Reasoning
Iteration
Collaborative Working

บทคัดย่อ

กว่าทศวรรษที่ผ่านมา คำว่า “การคิดเชิงออกแบบ” ได้รับความสนใจเพิ่มมากขึ้นในบริบทต่างๆ อย่างกว้างขวาง และเป็นที่คุ้นเคยเพิ่มมากขึ้นในพื้นที่นอกเหนือวิชาชีพด้านการออกแบบ การค้นคว้าวิจัยเพื่อเรียนรู้ถึงศักยภาพของการคิดเชิงออกแบบในการเชื่อมโยงองค์ความรู้ข้ามขอบเขตวิชาชีพ ตลอดจนบทบาทของการออกแบบในฐานะ ตัวแทนของการสร้างความเปลี่ยนแปลงทั้งในด้านนวัตกรรมและการเปลี่ยนแปลงทางสังคม เป็นสองกลไกหลักสำหรับข้อวิพากษ์ที่ขยายวงกว้างอย่างรวดเร็วในบริบทนอกเหนือวิชาชีพด้านการออกแบบ งานศึกษานี้ทำให้เกิดความเข้าใจ เชิงลึกในการนำแนวทางของการคิดเชิงออกแบบไปปฏิบัติ ในบริบทที่นอกเหนือจากวิชาชีพด้านการออกแบบ เพื่อสำรวจตรวจสอบว่าการคิดเชิงออกแบบถูกทำความเข้าใจและนำไปใช้ในเชิงปฏิบัติอย่างไร ในแนวทางนอกเหนือ วิชาชีพด้านการออกแบบ การวิเคราะห์นี้ได้พิจารณาบทความ 345 บทความ จากฐานข้อมูลของ Scopus ระหว่างปี ค.ศ. 2002 และ ค.ศ. 2017 ที่ได้รวมเอาคำว่า “design thinking” (การคิดเชิงออกแบบ) เป็นคำสำคัญ ผลการวิเคราะห์ พบว่า การคิดเชิงออกแบบถูกใช้ในฐานะกลไกในการสร้างและกระตุ้นสนับสนุนนวัตกรรม และการเปลี่ยนแปลงทางสังคม ผลของการศึกษานี้แสดงให้เห็นว่า การคิดเชิงออกแบบสามารถส่งเสริมแนวทางใหม่ๆ ต่อนวัตกรรม รวมทั้งปัญหาทางสังคมที่ซับซ้อนที่เกิดขึ้นอย่างต่อเนื่อง ผ่านกรอบแนวคิดของการมีส่วนร่วมสร้าง (co-creation) การคิดเชิงระบบ (systemic thinking) การให้เหตุผลแบบแอบดักทีฟ (abductive reasoning) หรือการให้เหตุผลโดยสมมติฐานใหม่จากข้อมูลที่ผ่านการสังเกตและวิเคราะห์ และการทำซ้ำ (iteration) ผลการวิเคราะห์เผยให้เห็นว่า การริเริ่มใช้แนวทางของแนวคิดเชิงการออกแบบเอื้อให้เกิดผลลัพธ์ที่เป็นบวกในงานด้านการจัดการธุรกิจ ด้านนวัตกรรมทางสังคม และด้านการศึกษา

คำสำคัญ
การคิดเชิงออกแบบ
การสร้างคุณค่าร่วมกัน
การคิดเชิงระบบ
การให้เหตุผลแบบแอบดักทีฟ
การทำซ้ำ
การทำงานร่วมกัน

Introduction

In recent times there has been increased attention paid to design thinking as a strategic resource in both managerial and social debates. A paradigm shift in the design-thinking approach from traditional design to emerging design practices has moved the focus of the design discipline from the design of products to designing for people's needs and/or social needs. Several scholars have highlighted the potential of design thinking to contribute to a wide range of contexts outside the professional design field (e.g., Johansson-Sköldberg, Woodilla & Çetinkaya, 2013). Design thinking is acknowledged as both an essential tool and an exciting new approach for simplifying and humanizing problems in areas ranging from business management (Ben Mahmoud-Jouini, Midler & Silberzahn, 2016; Carlgren, Rauth & Elmquist, 2016; Brown, 2008) to provision of public services and social issues (Davis, Docherty & Dowling, 2016; Brown, 2015; Brown & Wyatt, 2010). Thus, design thinking has been used to tackle more complex problems than those related to its traditional role in enhancing the appearance and functionality of products.

This study provides practical insights into how to use design-thinking approaches to tackle challenges in area outside the design profession. Focusing on the new discourse, the objective is to understand the use of design thinking in solving complex issues and how it has been applied to a remarkably diverse range of problems and contexts. This study examines this range of applications by analyzing 345 articles from the Scopus database between 2002 and 2017 that included "design thinking" as a keyword. The implementation of a design-thinking approach in several contexts is analyzed and conclusions are drawn regarding the potential of design thinking as a mechanism for promoting and enabling social change and innovation to explain the mechanism by which design thinking is understood and applied in practice.

This study introduces the core elements of design thinking as applied to social transformation and innovation and shows how it can supplement current innovation in relation to social issues and practices. The study shows how design thinking can foster new approaches to solving complex and persistent social problems through co-creation, systemic thinking, abductive reasoning, and iteration as it seeks to identify insights into the practical use of a design-thinking approach in social transformation and innovation. The analysis reveals that initiatives using design-thinking approaches experienced positive outcomes in the fields of business management, social innovation, and education.

The Role of a Design Thinking Approach in Non-designerly Contexts

Design thinking represents a way of thinking about a range of problems in the same way in which designers tackle design problems (Williams, 2014). Within the design realm, it represents different approaches to "designerly thinking," or ways of describing what designers do in practice (Carlgren, Rauth & Elmquist, 2016; Liedtka, 2015; Johansson-Sköldberg, Woodilla & Çetinkaya 2013; Kimbell, 2011). From the point of view of design theory, the various definitions of design thinking include an approach to creative problem-solving (Carlgren, Rauth & Elmquist, 2016; Liedtka, King & Bennett, 2013), an abductive way of thinking (Carlgren, Rauth & Elmquist, 2016; Leavy, 2011; Martin, 2009), and a methodology that can be used in multidisciplinary settings (Carlgren, Rauth & Elmquist, 2016; Stanford d school, 2010; Brown, 2008; Kelly & Littman, 2001). However, scholars have attempted to define design thinking using various approaches, and the term has different meanings depending on the context in which it is used. In a business and management context, it has been characterized as an iterative, user-centered approach that promotes creativity and innovation, as well as a mechanism that adds value, unlocks

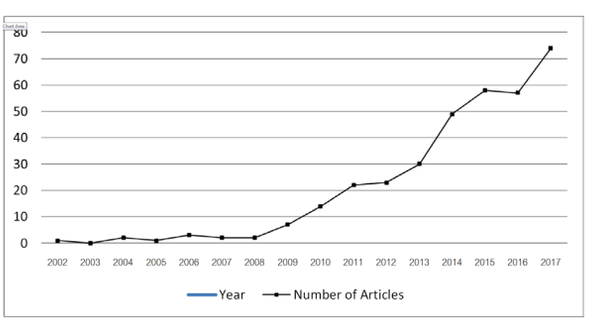
innovation, and generates economic benefits (Carlgren, Rauth & Elmquist, 2016; D'Ippolito, 2014; Johansson-Sköldberg, Woodilla & Çetinkaya, 2013; Brown, 2008).

Design thinking is also recognized as an instrument for societal change in terms of the delivery of public services (Davis, Docherty & Dowling, 2016; Bason, 2010). There is evidence that design thinking is being implemented for social transformation and innovation in many different contexts and sectors, and from a theoretical perspective, design thinking is a fundamental component of innovation (Patel & Mehta, 2017). Previous studies on design thinking have identified its role in exploring complex problems that emerge in times of rapid change (Davis, Docherty & Dowling, 2016; Buchanan, 1992) and attributes that enable a systemic design process that leads to innovative solutions in response to complex business and social issues (Davis, Docherty & Dowling, 2016; Martin, 2009; Verganti, 2009). Design thinking is acknowledged as both an essential tool and an exciting new approach for problem-solving in areas such as management, public service delivery, and social transformation. Design thinking involves bringing together multiple models of systemic thinking, modalities of practice, and holistic perspectives. It addresses complex problems in uncertain contexts and mobilizes a range of tools and attitudes to that end (Ben Mahmoud-Jouini, Midler & Silberzahn, 2016).

Design thinking is attracting increasing attention as a way of developing novel solutions to complex challenges in fields such as business, management, and higher education (Gachago, Morkel, Hitge, Zyl & Ivala, 2017). The significant traits of design thinking promoted by its advocates in a range of non-design sectors include strategies for addressing complex, intractable, ill-structured issues. Design thinking has been identified as a hypothesis-driven approach to creating solutions that contribute to the process of social transformation (Liedtka, 2014). It is particularly well-suited to tackling situations in which the problem is not clearly articulated (Ben Mahmoud-Jouini, Midler & Silberzahn, 2016; Liedtka, 2014; Cassim, 2013; Lawson & Dorst, 2013; Cross, 2011). Design thinking is a "problem-defining and -solving" approach that provides a heuristic framework that supports participants dealing with complex issues in collaborating on generating solutions (Ben Mahmoud-Jouini, Midler & Silberzahn, 2016; Tschimmel, 2012; Martin, 2009).

Methodology

This study examines the application of design thinking in a range of contexts by analyzing Scopus database articles that include "design thinking" as a keyword. The use of the term "design thinking" in Scopus commenced in 2002. Therefore, the analysis includes 345 peer-reviewed articles that were added to the Scopus database between 2002 and 2017. The number of documents has changed since the articles were extracted, but for simplicity, the study focuses on the 345 registered articles from 2002 to 2017 that were retrieved on 5 January 2018. Figure 1 shows the number of articles from 2002 to 2017. It can be seen that there were few articles up until 2008, after which the number steadily increased. Of the total of 345 articles, 192, or approximately 56%, were full-length papers published in English. Of these, 110 related to the design profession, while 82 addressed contexts outside the design profession.



Source: Scopus (https://www.scopus.com/search/form.uri?zone=TopNavBar&origin=resultslist&display=basic). Retrieved 5 January, 2018

Figure 1. Number of design-thinking articles.

Of the 82 articles relating to contexts outside the design profession, 19 that were difficult to analyze in terms of the deconstruction of the area using design

thinking and the practical application of the design-thinking methodology (e.g. papers that had insufficient information or contained only highlights) were excluded from the sample. The remaining 63 articles that focused on contexts outside the design profession were divided into three different categories based on the subject areas and the content of each article including management, social innovation, and education. The subject areas are based on information obtained from SCImago Journal and Country Rank.

Design Thinking Inplementations outside the Design Professions

The analysis illustrates that design thinking is applicable to a broad array of problems in society ranging from management to social innovation. Tables 1, 2, and 3 show design thinking references in a non-designerly context and key themes in design-thinking implementation in the fields of management, social innovation, and education, respectively. Most of the articles in subject areas outside the design profession were in the field of education (46%), with management and social innovation each accounting for 27% of all articles.

In business and management, the rigorous methodology of design thinking works as a mechanism to nurture sustainability and innovative problem-solving. Design thinking offers creative techniques that increase people's ability to visualize multi-functionality, manage uncertainty, and develop a sustainable business model. In the business domain, design thinking has been used to address complex organizational challenges (Ben Mahmoud-Jouini, Midler & Silberzahn, 2016; Gaim & Wåhlin, 2016; Lewis et al., 2017; Liedtka, 2014; Price & Wrigley, 2016), implement strategies (Dong, Garbuio & Lovallo, 2016), and develop organizational decision-making capabilities (Frisk, Lindgren & Mathiassen, 2014), as well as enhancing the sustainable business modeling process (Geissdorefer, Bocken & Hultink, 2016; Goodspeed et al., 2016; Martin, Paulo & Steve). Many firms have integrated the design-thinking process with other models to achieve increased productivity. Banerjee and Mukhopadhyay (2016) combined the design-thinking process and management theory to create a new framework for supply chain management. Bosh and Bosch-Sijtsema (2011) proposed an integration of the design-thinking process and a software production line to enhance customer feedback and engagement. Luotola, Hellström, Gustafsson & Peminova-Harikoski, (2017) used the design-thinking process and actor–network theory to explore how certainty evolves between a seller and a buyer to extend the value co-creation literature. O'Driscoll (2016) developed an information system using a combination of active design research, design thinking, and agility. Paris and McInnis-Bowers (2017) developed a program for socially conscious entrepreneurs using human-centered design thinking.

In terms of social innovation, design thinking enables a collaborative approach to solving complex problems, wherein all stakeholders co-create solutions (Valentine, Kroll, Bruce, Lim & Mountain, 2017). Social innovation deals with social challenges, wherein design thinking enhances the exploration of people's behaviors and mind-sets. The design-thinking approach, with its unique conceptualization, process, and tools, encourages knowledge transfer through collaborative exchange and individual creativity involving open, reflective conversations. The significant impact of design-thinking implementation can be observed in the health-care sector. In using design thinking for social innovation, stakeholder collaboration is the key leverage point. The design-thinking approach has been implemented to facilitate a process of collaboration in health-care development, to analyze innovation policy and the organization's role in the provision of health-care services, and to advance and transform service design based on stakeholder needs. Design thinking has been used in health-care management (Bazzano & Martin, 2017; Partridge, 2017; Thies, 2015; Valentine, Kroll, Bruce, Lim & Mountain, 2017), health-care product design and

Table 1. Key themes in design-thinking implementation and references to design thinking in management.

Authors	Journal	Key themes in design-thinking implementation
Management (17 articles)		
Banerjee & Mukhopadhyay, 2016	Journal of Enterprise Information Management	- Empathy, observation, and rational thoughts
Bantau & Rayburn, 2016	The Service Industries Journal	- IDEO's human-centered design (HDC)
Ben Mahmoud-Jouini et al., 2016	Project Management Journal	- Tools: visual or narrative elements, deep understanding of users, structured collaborative work, identifying assumptions, prototyping, field experiments
Bosch & Bosch-Sijtsema, 2011	Software Practice and Experience	- Customer engagement (collaboration), iteration
Dong et al., 2016	California Management Review	- Framing and abduction
Frisk et al., 2014	The European Journal of Information Systems	- Design attitude: representing, knowing, generating, applying, reflecting
Gaim & Wåhlin, 2016	Scandinavian Journal of Management	- Building blocks of design thinking (perspective: integrative, structure: symmetric, mindset: open-mindedness, process: abductive re(framing))
Geissdorefer et al., 2016	Journal of Cleaner Production	- Stanford d school design-thinking process
Goodspeed et al., 2016	Marine Policy	- Stanford d school design-thinking process
Lewis et al., 2017	Journal of Business Strategy	- Stanford d school design-thinking process
Liedtka, 2014	Strategy & Leadership	- Ten tools: 1) visualization, 2) journey mapping, 3) value chain analysis, 4) mind mapping, 5) brainstorming, 6) concept development, 7) assumption testing, 8) rapid prototyping, 9) customer co-creation, 10) learning launch
Luotola et al., 2017	Industrial Marketing Management	- Co-creation, abductive
Martin et al., 2017	Procedia Manufacturing	- Eight sequential but iterative phases (1. ideation, 2. concept design, 3. virtual prototyping, 4. experimenting, 5. detail design, 6. piloting, 7. launch, 8. adjustment and diversification)
O'Driscoll, 2016	Journal of Decision Systems	- User-centricity, iterative learning and development, extensive team communication
Paris & McInnis-Bowers, 2017	Journal of Management Education	- Human-centered design thinking
Price & Wrigley, 2016	Journal of International Consumer Marketing	- Deep customer insight methods (persona design, storytelling, customer narratives, scenarios, co-design, touch-point timeline, shadowing)
Steen et al., 2014	International Journal of Innovation and Technology Management	- Human-centered design

Table 2. Key themes in design-thinking implementation and references to design thinking in social innovation.

Authors	Journal	Key themes in design-thinking implementation
Social Innovation (17 articles)		
Bazzano & Martin, 2017	The Design Journal	- IDEO's human-centered design (HCD)
Cheung, 2012	The Design Journal	- User-centered, holistic
Clune & Lovkrey, 2014	Journal of Cleaner Production	- The double-diamond method of life cycle and design thinking (1. problem exploration, 2. problem definition, 3. why are the practices as they are, what are the alternatives?, 4. validating alternatives and developing a plan)
Eckman et al., 2016	Journal of Medical Engineering & Technology	- All stakeholders' engagement (collaboration) and systemic method
Grobler & Villie, 2017	The Electronic Journal of Information Systems in Developing Countries	- IDEO's HCD
Hill, 2016	Journal of Cultural Heritage Management and Sustainable Development	- People-centeredness, holistic perspective, problem exploring and iterative process
Hopkins et al., 2016	Healthcare	- A framework using a multidisciplinary approach, brainstorming and rapid digital prototyping
Lam & Shulha, 2015	American Journal of Evaluation	- Six phases: delineation, collaboration, prototyping, illumination, and reality testing
Mummah et al., 2017	International Journal of Behavioral Nutrition and Physical Activity	- IDEAS framework: 1) empathize with users, 2) specify target behavior, 3) ground in behavioral theory, 4) ideate implementation strategies, 5) prototype potential products, 6) gather user feedback, 7) build minimum viable product, 8) pilot potential efficacy and usability
Ortega et al., 2014	International Journal of Innovation Science	- IDEO's HCD and social impact model
Partridge, 2017	The Design Journal	- Participatory design methods
Petersen & Hempler, 2017	BMC Medical Informatics and Decision Making	- IDEO's HCD
Ramos et al., 2016	Progress in Community Health Partnerships: Research, Education, and Action	- The six basic steps of design thinking are empathy, define, ideate, prototype, implement, and learn
Selloni & Corubolo, 2017	The Design Journal	- Service design/co-design
Thies, 2015	Interaction Design and Architecture(s) Journal	- User-centered design
Valentine et al., 2017	The Design Journal	- Fifteen components to Design Sprint: (1) knowledge transfer; (2) individual creativity; (3) brainstorming; (4) energizers; (5) collaborative knowledge exchange; (6) ideation; (7) ethnographic interviewing; (8) en masse feed-forward sessions with open reflective conversations; (9) prototyping; (10) exposition; (11) take down and tidy up; (12) PechaKutcha; (13) teamwork; (14) assessment; and (15) celebration
Warnecke, 2016	Review of Social Economy	- A framework of human-centered design thinking

Table 3. Key themes in design-thinking implementation and references to design thinking in education.

Authors	Journal	Key themes in design-thinking implementation
Education (29 articles)		
Adams et al., 2016	Advances in Engineering Education	- Design-thinking paradigms (aesthetic, functional, technical, entrepreneurial, and human-centered)
Alhamdani, 2016	Journal of Applied Security Research	- Understand, observe, define, ideate, prototype, test, and feedback
Baaki & Luo, 2017	Tech Trends	- Collaborative working and learning environment, ideation and the iterative problem-solving process
Benson & Dresdow, 2015	Journal of Innovative Education	- IDEO's human-centered design (HCD) method, inspiration, ideation, implementation
Biffi et al., 2017	Education and Training	- A practice-based focus on the relationship between creation and reflection on the creation; prototyping and iteration
Byrne et al., 2017	IEEE Transactions on Education	- The workshop was based on the Bridge21 model for 21st-century learning, which emphasizes teamwork, learning by doing, and technology-mediated project work
Cahn et al., 2016	Journal of Interprofessional Care	- IDEO's HCD
Crichton, 2014	Electronic Journal of E-Learning	- Stanford d school design-thinking process)/collaboration and tinkering/ testing
Drake, 2017	On the Horizon	- IDEO's HCD
Duarte et al., 2011	International Journal of Co-Creation in Design and the Arts	- Co-design
Fairburn, 2011	Acta Astronautica	- IDEO's HCD, Stanford University's K12 project, co-creation
Frabi et al., 2016	Journal of Assistive Technologies	- IDEO's HCD
Gachago et al., 2017	International Journal of Educational Technology in Higher Education	- Design-thinking mindset with seven elements: a focus on human values, the ability to craft clarity, embracing experimentation, being mindful of the process, a bias towards action, radical collaboration, and a preference to show rather than tell
Glen et al., 2015	The International Journal of Management Education	- Six phases: problem finding, observation, visualization and sense making, ideation, prototyping, and testing
Haruyama et al., 2013	International Journal of System Engineering	- Active learning project sequence: team-based creation of ideas, design from the viewpoint of users, systematic approach from the idea-creation phase, idea sharing and proposal using prototypes, development of effective communication to express ideas
Henriksen et al., 2017	Thinking Skills and Creativity	- Stanford d school design-thinking process
Huq & Gilbert, 2017	Education and Training	- IDEO's HCD method (inspiration, ideation, implementation)/the double-diamond model that addresses four key iterative cycles in the design process: discover, define, develop, and deliver
Khalaf et al., 2013	Advances in Engineering Education	- Iterative divergent-convergent process, systems thinking, systemic iterative interplay between divergent and convergent questioning in engineering design education
Lam & Shulha, 2015	American Journal of Evaluation	- Delineation, collaboration, prototyping, illumination, and reality testing
Lancione & Clegg, 2015	Management Learning	- Harvard's 'x Design' lab and conference; Stanford's 'Innovation Master Series' and 'Design Thinking Boot Camp'; Case Western's Weatherhead School of Management 'Manage by Designing' initiative, launched in 2002; Rotman School of Management, with its new Rotman Design Challenge 2013; and Yale School of Management, which is catching up with a student club on 'Design and Innovation'
Lewis & Elaver, 2014	The International Journal of Management Education	- Discovery, interpretation, ideation, experimentation, evolution
Messuti et al., 2014	Mobile as a Mainstream – Towards Future Challenges in Mobile Learning	- A human-centered, collaborative and experimental approach, (discovery, interpretation, ideation, experimentation, evolution)
Niccum et al., 2017	Medical Education Online	- Collaboration and prototyping through interdisciplinary teaching and active learning
Nielsen & Stovang, 2015	Education and Training	- Human-centered and iterative/co-creation
Pittarello & Pellergrini, 2017	Multimedia Tools and Applications	- User-experience design
Retna, 2016	Asia Pacific Journal of Education	- Empathy: deep understanding, prototyping
Steinbeck, 2011	Scientific Journal of Media Literacy	- Stanford d school design-thinking process, IDEO's HCD, Stanford University 's ME310 program
Tan & Wong, 2012	International Journal of Children's Spirituality	- IDEO's HCD
Welsh & Dehler, 2013	Journal of Management Education	- User-centered process, collaboration

application (Cheung, 2012; Eckman, Gorski & Mehta, 2016; Hopkins, Dunn, Bourgeois, Roger & Chiang, 2016; Mummah et al., 2017; Petersen & Hempler, 2017), and service design (Clune & Lockrey, 2014). Design thinking has also been used in community development (Grobler & Villiers, 2017; Ramos, Trinidad, Correa & Rivera, 2016), social enterprise (Selloni & Corubolo, 2017), and entrepreneurship programs (Warnecke, 2016).

Design thinking has been used in the field of education to develop strategies and principles for ways of thinking associated with the innovative practices needed to address challenges in an educational setting. Design thinking is a methodology that can be used to generate innovative ideas (Brown, 2009; Martin, 2009). To develop the creativity necessary for innovation in response to complex problems, design thinking encourages users to focus on the discovery of root causes and needs, collaborating across disciplines and experimenting with iterative design solutions (Shapira, Ketchie & Nehe). In the 21st century, education across a range of disciplines has been influenced by the application of design thinking to a search for improved methodologies for educational transformation and pedagogical exploration (Drake, 2017; Hug & Gilbert, 2017; Adam, Radcliffe & Fosmire, 2016; Crichton, 2014; Khalaf, Balawi & Hitt, 2013; Welsh & Dehler, 2013; Fairburn, 2011), designing and integrating curricula (Pittarello & Pellegrini, 2017; Alhamdani, 2016; Haruyama, Kim, Beiter, Dijkema & de Weck, 2013), understanding the decision-making process (Benson & Dresdow, 2015), facilitating new learning approaches (Biffi, Bissola & Imperatori, 2017; Byrne, O'Sullivan & Sullivan, 2017; Niccum et al., 2017; Nielsen & Stovang, 2015; Duarte, Lulham & Kaldor, 2011), evaluating interprofessional education (Cahn et al., 2016), encouraging student participation and enhancing student learning (Frabi, Andrews & Pukki, 2016; Retna, 2016; Tan & Wong, 2012), developing creative and innovative models for teaching and learning (Gachago, Morkel, Hitge, Zyl & Ivala, 2017; Henriksen, Richardson & Mehta, 2017; Lancione & Clegg, 2015; Lewis & Elaver, 2014; Steinbeck, 2011), managing the innovation process (Glen, Suciu, Baughn & Anson, 2015), and improving knowledge sharing and communication (Messuti, Wambeke, Kalz & Bruschi, 2014).

Conceptual Framework

To investigate and deconstruct the dominant characteristics of contemporary theories on design thinking, the framework developed in this study was directed through a critical realism following the approach of Sayer (1992). Critical realism is a useful philosophical framework for social science methodology and a relatively new approach to ontology, epistemology, and axiology:

Epistemologically, the aim of critical realism is to explain the relationship between experiences, events, and mechanisms. The perspective emphasizes questions of "how and why" a particular phenomenon came into being, got its specific character and so on (Jeppsen, 2005, p. 5).

Althought there is a pool of scholars that critical realists often draw upon and a number of different point of views and approaches to critical realism (e.g., Bhaskar, 1978; Steinmetz, 1998), this paper adopted a framework of Sayer since this approach can demonstrate both of a philosophical justification for case research and a guide to its practical uses (Sayer, 1992; Easton, 2010; Di Russo, 2016). A theoretical application of critical realism generates knowledge through causal analysis in terms of epistemological position (Wuisman, 2005; Di Russo, 2016). The causal explanation approach relies on determining the fundamental explanation of what causes events to happen and is based on the critical realist view of causation:

Events arise from the workings of mechanisms which derive from the structures of objects, and they take place within geo-historical contexts (Sayer, 2000, p. 15).

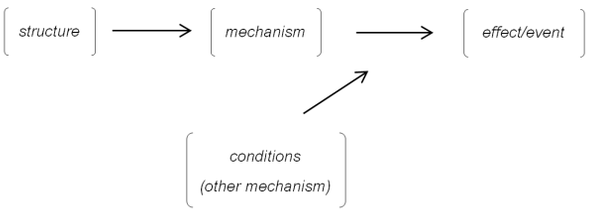


Figure 2. Critical realist view of causation. (Sayer, 2000, p.15)

Figure 2 shows how the critical realist view of causation is structured in terms of the relationships among causes and effects. Events or effects are the outcome that critical realists investigate. The structure of casual explanation is the relationships among the concepts that have been dicussed and mechanisms are the ways in which things act. Mechanisms connect and combine things that cause events to occur and are at the heart of causal explanation (Easton, 2010).

A framework of design-thinking characteristics was developed based on Kimbell (2011) and the analysis of articles in terms of the key mechanisms of design-thinking implementation. Based on the cognitive styles of describing design thinking (Kimbell, 2011), the analysis was used to create a framework based on the characteristics of what designers think and do. The framework was created to bridge the gap between theoretical knowledge on design thinking and its practical implementation. Various cases illustrated the value of design thinking as an innovative approach to complex challenges. The study examines how design thinking might utilize this proven and accessible problem-solving process by analyzing the principles associated with each design-thinking structure. Table 4 provides a framework of design-

Table 4. A framework for design-thinking characteristics based on critical realist view of causation.

Structure	Mechanism	Conditions	Effects/Events
1. Co-creation	Collaboration	Collaborative working (to include all stakeholders throughout the process and to understand the points of view of different stakeholders)	- Reflective and collaborative learning environment (Baaki & Luo, 2017) - Three imperatives for project management (Ben Mahmoud-Jouini et al., 2016) - Customer-value-building improvement (Bosch & Bosch-Sijtsema, 2011) - Community well-being and safety improvement (Duarte et al., 2011) - Improved health-care access in the developing world (Eckman et al., 2016) - New school of excellence model (Fairburn, 2011) - Organizational decision-making transformation (Frisk et al., 2014) - New education curriculum (Haruyama et al., 2013) - Conceptual model for adaptive reuse of heritage assets (Hill, 2016) - Pre-formative development of an educational program (Lam & Shulha, 2015) - Innovative ways of using design thinking in companies (Liedtka, 2014) - Micro-level processes of co-creation (Luotola et al., 2017) - Sustainable business model innovation (Martin et al., 2017) - Landscape analysis of innovation and entrepreneurship in medical education (Niccum et al., 2017) - Micro-level processes of co-creation analysis (Nielsen & Stovang, 2015) - Self-management of adolescents in health and well-being (Paetridge, 2017) - New generation of collaborative services in social enterprises (Selloni & Corubolo, 2017) - Strategic framework for social innovation in health care (Valentine et al., 2017) - Integrative learning (Welsh & Dehler, 2013)

Table 4. A framework for design-thinking characteristics based on critical realist view of causation. (continue)

Structure	Mechanism	Conditions	Effects/Events
		Developing empathy (to develop a deep and diverse understanding of the explicit and latent needs, desires, and values of stakeholders)	- Global data-sharing for educational transformation (Adam et al., 2016) - Cryptography curriculum using a design-thinking model (Alhamdani, 2016) - Framework application on a case of supply (Banerjee & Mukhopadhyay, 2016) - Transformation of service innovation and design using technology (Bantau & Rayburn, 2016) - Improved progress in achieving health equity and improving population-level health outcomes (Bazzano & Martin, 2017) - Developing an undergraduate decision-making course (Benson & Dresdow, 2015) - Learning model for teenagers to promote careers in computer science (Byrne et al., 2017) - Interprofessional education in patient-centered care (Cahn et al., 2016) - Innovative product development in health care (Cheung, 2012) - Transformative pedagogy (Crichton, 2014) - Innovative pedagogy for teaching journalism (Drake, 2017) - Online toolkit for autistic students (Frabi et al., 2016) - Developing e-learning champions (Gachago et al., 2017) - Sustainable business model innovation (Geissdorefer et al., 2016) - Tools for ecosystem management (Goodspeed et al., 2016) - Information and communication technology development for communities (Grobler & Villie, 2017) - Creative approach of educational problem in practice (Henriksen et al., 2017) - Transformative entrepreneurship education (Hug & Gilbert, 2017) - New model of business education (Lancione & Clegg, 2015) - Long-term strategic interorganizational relationships (Lewis et al., 2017) - Mobile app to increase vegetable consumption among overweight adults (Mummah et al., 2017) - Micro-level processes of co-creation analysis (Nielsen & Stovang, 2015) - Information system requirements analysis (O'Driscoll 2016) - Social impact of innovations in business models (Ortega et al., 2014) - Developing socially conscious entrepreneurs and intrapreneurs (Paris & McInnis-Bowers, 2017) - Numerous mobile applications to support diabetes-self-management (Petersen & Hempler, 2017) - Computer science educational experiences for an undergraduate course (Pittarello & Pellergrini, 2017) - Deep customer insight innovation framework (Price & Wrigley, 2016) - Community-based health education programs (Ramos et al., 2016) - Teachers' perceptions, experiences, and challenges in adopting design thinking (Retna, 2016) - Promoting shared understanding in innovation projects (Steen et al., 2014) - Building creative competence in globally distributed courses (Steinbeck, 2011) - Spiritual ideals for religious education (Tan & Wong, 2012) - Better understanding of underlying problems in health care (Thies, 2015) - Gender-sensitive entrepreneurship programs (Warnecke, 2016) - Integrative learning (Welsh & Dehler, 2013)
2. Systemic thinking	Holistic perspective	Explore the problem (to understand the system and its interrelationships and to develop a holistic understanding of systems)	- Innovative product development in health care (Cheung, 2012) - Improved health-care access in the developing world (Eckman et al., 2016) - A conceptual framework for synthesizing paradoxical tensions in organizations (Gaim & Wåhlin, 2016) - A new education curriculum (Haruyama et al., 2013) - A conceptual model for adaptive reuse of heritage assets (Hill, 2016) - Managing and fostering creativity in business education (Lewis & Elaver, 2014)

Table 4. A framework for design-thinking characteristics based on critical realist view of causation. (continue)

Structure	Mechanism	Conditions	Effects/Events
		Problem framing (to identify a larger problem space to help create a larger solution space)	- Three imperatives for project management (Ben Mahmoud-Jouini et al., 2016) - Generative sensing to enhance option generation in companies (Dong et al., 2016) - An innovative, interdisciplinary approach to engineering design education (Khalaf et al., 2013)
		Defining problem (to identify assumptions and statements to inspire creative solutions)	- Improved progress in achieving health equity and improving population-level health outcomes (Bazzano & Martin, 2017) - Environmental sustainability strategies (Clune & Lovkrey, 2014) - Transformative pedagogy (Crichton, 2014) - Organizational decision-making transformation (Frisk et al., 2014) - Sustainable business model innovation (Geissdorefer et al., 2016) - A business curriculum for the innovation process (Glen et al., 2015) - Tools for ecosystem management (Goodspeed et al., 2016) - A creative approach of educational problem in practice (Henriksen et al., 2017) - A new model of business education (Lancione & Clegg, 2015) - Long-term strategic interorganizational relationships (Lewis et al., 2017) - Innovative ways of using design thinking in companies (Liedtka, 2014) - Micro-level processes of co-creation (Luotola et al., 2017) - Building creative competence in globally distributed courses (Steinbeck, 2011)
3. Abductive reasoning	Creative problem-solving	Ideating solutions (to generate various ideas to move beyond obvious solutions, harness creativity, and create diverse perspectives for a broader range of possibilities)	- Cryptography curriculum using a design-thinking model (Alhamdani, 2016) - A reflective and collaborative learning environment (Baaki & Luo, 2017) - Transformation of service innovation and design using technology (Bantau & Rayburn, 2016) - Developing an undergraduate decision-making course (Benson & Dresdow, 2015) - Interprofessional education in patient-centered care (Cahn et al., 2016) - Transformative pedagogy (Crichton, 2014) - Generative sensing to enhance option generation in companies (Dong et al., 2016) - Innovative pedagogy in teaching journalism (Drake, 2017) - Developing a new schools of excellence model (Fairburn, 2011) - Online toolkit for autistic students (Frabi et al., 2016) - A conceptual framework for synthesizing paradoxical tensions in organizations (Gaim & Wåhlin, 2016) - Sustainable business model innovation (Geissdorefer et al., 2016) - A business curriculum for the innovation process (Glen et al., 2015) - Tools for ecosystem management (Goodspeed et al., 2016) - Information and communication technology development for communities (Grobler & Villie, 2017) - A creative approach of educational problem in practice (Henriksen et al., 2017) - Transformative entrepreneurship education (Hug & Gilbert, 2017) - A new model of business education (Lancione & Clegg, 2015) - Long-term strategic interorganizational relationships (Lewis et al., 2017) - Managing and fostering creativity in business education (Lewis & Elaver, 2014) - Sustainable business model innovation (Martin et al., 2017) - Mobile learning interventions at work (Messuti et al., 2014) - A mobile app to increase vegetable consumption among overweight adults (Mummah et al., 2017) - The micro-level processes of co-creation analysis (Nielsen & Stovang, 2015) - Innovative business model (Ortega et al., 2014) - Numerous mobile applications to support diabetes self-management (Petersen & Hempler, 2017) - Community-based health education programs (Ramos et al., 2016) - Building creative competence in globally distributed courses (Steinbeck, 2011) - Spiritual ideals for religious education (Tan & Wong, 2012) - Strategic framework for social innovation in health care (Valentine et al., 2017)

Table 4. A framework for design-thinking characteristics based on critical realist view of causation. (continue)

Structure	Mechanism	Conditions	Effects/Events
4. Iteration	Learning by doing	Experimentation (to encourage the exploration of several solutions and to learn to navigate situations of failure and turn failure into opportunities)	- A reflective and collaborative learning environment (Baaki & Luo, 2017) - Three imperatives for project management (Ben Mahmoud-Jouini et al., 2016) - Innovative theoretical framework for a postgraduate education program (Biffi et al., 2017) - Learning model for teenagers to promote careers in computer science (Byrne et al., 2017) - A conceptual model for adaptive reuse of heritage assets (Hill, 2016) - Managing and fostering creativity in business education (Lewis & Elaver, 2014) - Sustainable business model innovation (Martin et al., 2017) - Mobile learning interventions at work (Messuti et al., 2014) - Information system requirements analysis (O'Driscoll 2016)
		Rapid prototyping (to generate and test multiple alternative hypotheses and divergent strategies)	- Cryptography curriculum using a design-thinking model (Alhamdani, 2016) - Transformation of service innovation and design using technology (Bantau & Rayburn, 2016) - Improved progress in achieving health equity and improving population-level health outcomes (Bazzano & Martin, 2017) - Three imperatives for project management (Ben Mahmoud-Jouini et al., 2016) - Developing an undergraduate decision-making course (Benson & Dresdow, 2015) - Interprofessional education in patient-centered care (Cahn et al., 2016) - Transformative pedagogy (Crichton, 2014) - Innovative pedagogy in teaching journalism (Drake, 2017) - Developing a new schools of excellence model (Fairburn, 2011) - Online toolkit for autistic students (Frabi et al., 2016) - Sustainable business model innovation (Geissdorefer et al., 2016) - Tools for ecosystem management (Goodspeed et al., 2016) - Information and communication technology development for communities (Grobler & Villie, 2017) - A new education curriculum (Haruyama et al., 2013) - A creative approach of educational problem in practice (Henriksen et al., 2017) - Transformative entrepreneurship education (Hug & Gilbert, 2017) - An in-house electronic discharge follow-up platform (Hopkins et al., 2016) - The pre-formative development of an educational program (Lam & Shulha, 2015) - A new model of business education (Lancione & Clegg, 2015) - Long-term strategic interorganizational relationships (Lewis et al., 2017) - Innovative ways of using design thinking in companies (Liedtka, 2014) - A mobile app to increase vegetable consumption among overweight adults (Mummah et al., 2017) - Landscape analysis of innovation and entrepreneurship in medical education (Niccum et al., 2017) - The micro-level processes of co-creation analysis (Nielsen & Stovang, 2015) - Social impact of innovation in business model (Ortega et al., 2014) - Numerous mobile applications to support diabetes self-management (Petersen & Hempler, 2017) - Community-based health education programs (Ramos et al., 2016) - Teachers' perceptions, experiences and challenges in adopting design thinking (Retna, 2016) - Building creative competence in globally distributed courses (Steinbeck, 2011) - Spiritual ideals for religious education (Tan & Wong, 2012) - Strategic framework for social innovation in health care (Valentine et al., 2017)

thinking characteristics. The results show how design thinking can foster new approaches to complex, persistent problems through (1) co-creation, (2) systemic thinking, (3) adductive reasoning, and (4) iteration.

Design Thinking Approach

1. Co-creation

The first and most critical aspect of design-thinking implementation for social transformation and innovation is the co-creation strategy. Co-creation has emerged independently in several fields (Greenhalgh, Jackson, Shaw & Janamian, 2016). In business, "value co-creation" adopts a collaborative approach by considering customer engagement in the production process to achieve a mutually valued outcome, while in the design field, there has been a shift in perspective from designing for users to designing with users (i.e., from user-centered to co-designing or co-creation). The user-centered approach cannot address the scale or complexity of today's challenges because of the likelihood of future experiences of people, communities, and cultures that are unimaginable and uncertain (Sanders & Stappers, 2008).

Co-creation broadly refers to the effort to combine the views, input, and skills of people with myriad perspectives in addressing a specific problem. Co-creation is a creative approach that supports and facilitates the democratic involvement of people in addressing social challenges and encourages collaboration within organizations and among local communities (Szebeko & Tan, 2010). The essence of collaboration is respect for all stakeholders' experiences and viewpoints.

Focusing on a collaborative working platform whereby stakeholders can share their various perspectives and develop empathy, design-thinking approaches have been implemented with the aim of increasing the sense of ownership on the part of all participants. Design thinking enables them to understand different points of view and develop a deep and diverse understanding of the latent needs, desires, and values of other stakeholders. Collaboration brings stakeholders together to explore the root causes of the problem they are facing. Participants then work collaboratively to devise and test solutions aimed at key leverage points. Collaboration requires a team that reflects the diversity among the people affected by and involved in finding a solution to the problem at hand, and acknowledges the multi-layered reality of the system in which they are operating.

2. Systemic Thinking

Systemic thinking is the key to success in design-thinking implementation. Innovation and social transformations are associated with complex issues such as sustainability, change, and uncertainty, and thus require systemic thinking skills. Additionally, developing a shared conceptual "system sense" is even more important when effective collaboration is the aim (Senge, Lichtenstein, Kaeufer, Bradbury & Carroll, 2007). Social challenges and innovation require systemic solutions. To create change, innovation, and transformation of the social reality, participants must carefully consider the system they are trying to change. It is not sufficient to understand what is happening; one must also adopt a long-term perspective to understand what is happening over time. Moreover, there needs to be consideration of the underlying structures and thinking that may be causing problems (Reos Partners, 2017).

Systemic thinking is a way of understanding a system by focusing on key skills, including seeing interrelationships, not things, and processes, not snapshots (Senge, 1998). Systemic thinking helps us to discover the patterns of behavior, supporting structures, and mental models, including values, beliefs, and assumptions, that underlie a particular event. When people bound by mental models, no one can carry all the complex details of our world in our mind; but we keep images, assumptions and stories in our heads. Mental models can be simple

generalizations or complex theories. The most important point to grasp is that mental models shape how we act (Senge, 1992).

Key themes of design thinking associated with a holistic perspective include the implementation of problem exploration to understand the system and its interrelationships. By considering the interconnections and relationships between the various parts of a system, stakeholders can explore the underlying causes of the problem they are facing using environmental scanning to address gaps in their knowledge and develop a holistic understanding of the system. Problem framing helps participants to change the way in which they look at the system by encouraging them to expand their horizons to identify a larger problem space to help create a larger solution space. Finally, it helps them in defining the problem in a way that enables them to identify assumptions and statements that can help to inspire creative solutions.

3. Abductive Reasoning

Abductive reasoning is at the heart of design thinking. Abductive reasoning is a form of logical reasoning that introduces new hypotheses to explain given observations (Dong, 2016). Charles Sanders Peirce coined the term abduction when categorizing reasoning into three basic types: deduction, induction, and abduction. Peirce argued that abduction was the only kind of reasoning that could generate new ideas (Psillos, 2009). A learning-focused and hypothesis-driven approach, such as that proposed by Schön (1983), is central (Carlgren, Rauth & Elmquist, 2016) to design theory. Here, the idea is that while a scientific hypothesis approach focuses on what already exists, a design hypothesis approach is about what might be (Carlgren, Rauth & Elmquist, 2016). Design is experienced as evidence-based decision-making in an attempt to find new opportunities (Adam, Radciffe & Fosmire, 2011) in response to challenges.

Design thinking involves "designers" solving problems through collaborative, integrative thinking (Brown, 2008; Brown, 2009) using "abductive" logic (Dunne & Martin, 2006). Abduction has been described by Roger Martin as the "logic of what might be," and as being future-oriented (Kolko, 2010; Lockwood, 2010). Abductive logic is seen as the only type of logic that introduces new ideas, which occurs through the process of forming an explanatory hypothesis based on prior experience (Kolko, 2010; Dunne & Martin, 2006). In this sense, abductive logic differs from deductive and inductive logic, which focus on "what should be" and "what is," respectively (Liedtka, 2014; Martin, 2009; Dunne & Martin, 2006). Therefore, abductive reasoning enables the creation of new knowledge and insights (Beverland, Wilner & Micheli, 2015; Cross, 2011; Kolko, 2010).

Creative problem-solving involves processes, methods, and systems for approaching a problem using creativity. This process helps people to redefine problems and explore new solutions and possibilities. To create diverse perspectives and apply creative problem-solving using abductive reasoning, participants concentrate on idea generation. The key theme is a transition from identifying problems to creating solutions, as well as generating a broader range of possibilities. Participants can understand how different ideas relate to one another before comparing options and deciding which is best. Ideating solutions helps to generate alternatives to the present reality, and more potential solutions are able to be developed by adopting different approaches.

4. Iteration

Design is experienced as an exploration of unique attributes in an effort to investigate ideas, embrace risks that result from the exploration of unknowns, try new things, and think beyond traditional outcomes (Adam, Daly, Mann & Dall'Alba, 2011). Trial-and-error learning through iteration is the most significant characteristic of design thinking (Beverland, Wilner & Micheli, 2015). Iterative design is a process-based design-thinking framework that allows a cyclic process of prototyping, testing, analyzing, and refining

a work in progress with the aim of exploring a range of possible solutions (Denning, 2013; Brown, 2008; Laurel, 2003). By enabling the rapid creation and testing of ideas, the iterative prototyping process assists in generating feedback from potential users, refining idea development, and correcting costly errors before implementation (Szebeko & Tan, 2010). The iterative prototyping process encourages the development of a creative hypothesis environment involving "What if?" questions and problem-solving focusing on expected results that leads to new ideas and the testing of multiple possible solutions (Beverland, Wilner & Micheli, 2015; Dow, Heddleston & Klemmer, 2009).

Working experimentally is one of the key themes of design thinking. Experimentation is a learning process based on active reflection designed to encourage the exploration of multiple solutions. The key objective of experimentation is to create a safe space in which ideas can fail. Ideally, failures should happen early in the process so that lessons are learned and mistakes are not repeated. "Fail early, fail often" is an approach that provides important lessons that inform and improve ideas. The use of low-resolution prototypes or rapid prototyping in combination with an open environment that allows for failure and iteration is also considered important. Rapid prototyping is a key activity in the design-thinking process that is used to generate and test multiple alternative hypotheses and divergent strategies.

Discussion

In this study, the implementation of design thinking beyond the design profession is analyzed and explained using the proposed framework. The framework was developed based on the key characteristics of design thinking including co-creation, systemic thinking, abductive reasoning, and iteration. The principles underlying each characteristic, as well as the critical realism approach, are described to clarify the concept of design thinking. The focus of the study is the widespread appropriation of the term "design thinking" and its practical application. Increasing attention is being paid to design thinking as both an essential tool and an exciting new approach to problem-solving in both business and social arenas in response to concerns of ambiguous way of employments. The framework presented in this study aims to bridge the gap between theoretical knowledge in relation to design thinking and its practical implementation.

This study presents an overview of the contemporary trajectory of research on design thinking that embraces the current trend toward exploration of potential cross-boundary engagements. A design-thinking framework encourages creativity and shared understanding in relation to strategies aimed at promoting change, a collaborative working environment, and innovation. However, criticisms for design thinking were the inevitable consequence of its popularity. Design thinking is only as good as its implementation, and its effectiveness can only be measured by outcomes and applications (Norman, 2010). Thus, the debate continues regarding the effectiveness of the application of design thinking to complex challenges (Nussbaum, 2011; Norman, 2010).

It is important to take the arguments againt design-thinking approach into consideration. The true tension at the heart of the design-thinking debates is the effectiveness of its implementations. The practical insight into how to use design thinking to tackle challenges need to be provided. This study presents the implementation of design thinking to create new appoarch via a literature review and a framework of design-thinking characteristics. Supporting case studies can be observed from various cases that many government agencies across the world are beginning to use design thinking to creatively address mission objectives and improve processes for public services (e.g., Cunnington, 2018; Allio, 2014).

However, design thinking remains undertheorized and understudied. A lack of empirical evidence of the effectiveness of design thinking is a significant weakness. The limitations of this study are related to the use of academic papers from a single database. Future studies should include other databases and examine publications over a greater period of time. Additionally, further investigation of the cross-sector application of design-thinking approaches and strategies is necessary to increase our understanding of the connection between theoretical knowledge and its practical application, as well as the effectiveness of a design-thinking approach across a range of disciplines.

Conclusion

The framework presented in this study encourages a conversation space for conceptualizing the implementation of design thinking, and how professionals outside the design profession employ a design-thinking approach to cope with complex challenges. By reframing a problem in new and interesting ways, the implementation of design thinking can accelerate the creation of sustainable value for diverse stakeholders. Design thinking involves a collaborative and iterative approach based on the holistic perspective of creative problem-solving. Stakeholders are provided with the necessary skills to envision the problem and design their own solutions, working systemically and collaboratively with other stakeholders. Design-thinking approach produced an environmrnt of collaborative learning among stakeholders and held promise for development of new tools that better facilitate social transformation.

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