
Interdisciplinary Approach to Innovation Management Research: A Conceptual Methodological Framework

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Abstract: Investigating agile practices has been considered a foundational research area in innovation management. Design thinking is a dynamic, innovative agile practice that has not been properly investigated using a more interdisciplinary approach. Design thinking expert facilitators possess cognitive and metacognitive processes that aid in the knowledge exchange and adaptability necessary to conduct design thinking initiatives. An investigation into the mental model of these design thinking expert facilitators aids in improved knowledge exchange and adaptability, which would greatly benefit scholars and practitioners understanding how to better facilitate design thinking. To develop a design thinking expert mental model, a rigorous conceptual methodological framework including critical design thinking principle is needed to explore the expert facilitator mental model. The proposed mental model consists of six components. The proposed framework provides a significant foundation for design thinking, and the proposed research methods provide an interdisciplinary approach that greatly contributes to further innovation management understanding.

Keywords: agile practices, design thinking, knowledge exchange, educational research.

1 Problem

When companies want to accelerate innovation throughout their organization, they often implement agile practices (Hobbs & Petit, 2017). However, these companies cannot help but wonder why they might pick one agile practice approach over another (Zayat & Senvar, 2020; Edwards et al., 2019). In their seminal work, Tidd, Bessant, and Pavitt (2005) stated that “definitions of innovation may vary in their wording, but they all stress the need to complete the development and exploitation aspects of new knowledge, not just its invention” (pg. 13). Agile methods, such as design thinking, have been implemented in response to the need for enlarged knowledge sources and increased adaptability due to the fast-changing environment (Grass, Backmann, & Hoegl, 2020). We agree that increased

adaptability and the quality and vehicle of how knowledge is distributed enable companies to be more innovative, but research in innovation management must also investigate more closely the knowledge being exchanged by fostering novel, interdisciplinary research projects.

The last fifty years have seen a lot of research on innovation and agile practices, but we still do not fully understand why and how innovation actually occurs (Fagerberg, Mowery, and Nelson, 2005). One reason could be the lack of interdisciplinary research on innovation management. We argue that far too little attention has been paid to interdisciplinary research designs and the adaption of methods from other disciplines.

The aim of this paper is to propose an interdisciplinary conceptual framework for how to investigate agile practices (e.g., design thinking) and knowledge exchange. We present a conceptual model that argues for the value of utilizing existing educational research methods and that aims to better understand how knowledge is exchanged within agile practices. Our paper contributes to the call for an interdisciplinary approach in agile practices and educational research.

2 Current Understanding

Recently, there has been much interest in agile models (Edwards et al., 2019) and practices (Zielske, M., & Held, 2020). One of the most significant agile practices, design thinking, has made important contributions in the field of innovation management (Bessant & Maher, 2002; Schallmo, Williams, & Lang, 2018; Wattanasupachoke, 2012) and has received increased interest in educational fields (Chin et al., 2019). For example, Chin et al. (2019) explored how educators can better transfer learning strategies using design thinking. In their work, the authors concluded that future research should explore how to perform immediate evaluation of these important learning strategies. In addition, we identified design thinking as a well-suited agile practice to investigate further because educational researchers have also started to examine this innovation management concept more closely (Chen & Zhang, 2016). Later in this paper, we will argue that metacognition is an important learning strategy to improve the knowledge exchange (Borge, Aldemir, & Xia, 2019).

For companies that decide to use agile practices like design thinking, creating a real competitive advantage is one of the most critical deciding factors. We argue that researchers and practitioners must better understand why these design thinking groups produce better, more innovative prototypes. Groeger and Schweiter (2014) proclaimed that investigating the innovation processes and artifacts produced is important but argued that just as important are the participants' mindsets and behaviors.

Design thinking is considered an important managerial method for understanding problems and developing and testing new, innovative prototypes. Among the many different design thinking approaches, the main aims of this practice are to agree on a common problem, develop several ideas, and create a prototype. Surprisingly, there have been very few attempts to create a design thinking expert mental model (Leavy, 2010). For example, Leavy (2010) analyzed the facilitator principles of Roger Martin, a design thinking expert, who identified three design thinking principles: 1) knowledge funnel, 2) difference

between reliability and validity, and 3) abductive reasonings. This study provided fruitful contribution to the field of design thinking and management, but, based on the results, there seems to be a strong academic focus. Our design thinking mental model should address both academic and practitioner-oriented needs.

There is great interest in exploring design thinking in the learning environments (Soleas, 2015; Kavousi, Miller, & Alexander, 2019). The development of mental models is also popular in educational research (Greene & Azevedo, 2009). Management researchers have recognized the importance of empirically investigating design thinking-related cognitive and metacognitive processes in a business environment (Butler & Roberto, 2018), but opportunities remain to investigate these cognitive and metacognitive processes in a business environment. We argue that these cognitive and metacognitive processes significantly aid in facilitating knowledge exchange with any type of agile practice in a business environment.

According to Kiefer et al., (2005) knowledge exchange involves passing knowledge between users and producers in a group. Often, innovation management methods require collaboration (working) groups especially with a mixed group including different skills and know-how. Research has shown that knowledge exchange is a better indicator of successful group interactions with agile practices and building prototypes (Song, Almeida, and Wu, 2003). One of the prerequisites of knowledge exchange is the person's willingness to share. Very few publications have discussed knowledge exchange and design thinking in innovation management research (Barrett et al., 2015) in the educational research field (Chen and Zhang, 2016); more research is required. When we consider knowledge exchange, we must examine the design thinking facilitators and the design thinking participants.

3 Hypothesis

Innovation management lacks an interdisciplinary approach that might involve psychological or educational research methods. Learning scientists, a subdiscipline of social psychology and educational science, have already begun to investigate design thinking in a learning context (Chen and Zhang, 2016); now, it is time for innovation management researchers to utilize educational research methods in their field. We hypothesize that an interdisciplinary research approach will contribute to better understanding innovation management agile practices. We posit in this paper that it is beneficial to investigate a design thinking expert mental model by adapting existing educational research methods for innovation management research.

4 Initial Findings

The initial findings in this section support our assertion that research in design thinking would greatly benefit from more closely investigating mental models of design thinking experts. Because of the interdisciplinary nature of our proposed research, it was important to consider design thinking facilitator frameworks in design, educational, and management

research. We selected the frameworks based on the research quality and their practical value. In Table 1, we identify eight design thinking facilitator frameworks.

Table 1 Design Thinking Facilitator Frameworks

| <i>Author</i> | <i>Focus</i> | <i>Summarized Points</i> |
|---|-------------------------|---|
| Yair, K., Tomes, A., & Press, M. (1999). Design through making: crafts knowledge as facilitator to collaborative new product development. <i>Design Studies</i> , 20(6), 495-515 | Design Research | <ul style="list-style-type: none"> • Information gathering • Focus on production • Team motivation • Communication through craft • Integration • Design through making |
| Blumberg, A., & Golembiewski, R. T. (1976). <i>Learning and change in groups</i> . Penguin Group | Design Research | <ul style="list-style-type: none"> • Creates situations conducive to learning • Establishes a model of behavior • Provides new values in process • Facilitates the flow of information • Participates as an expert • Protects participants from unnecessary stress and attack |
| Minder, B., & Heidemann Lassen, A. (2018). The designer as facilitator of multidisciplinary innovation projects. <i>The Design Journal</i> , 21(6), 789-811 | Design Research | <ul style="list-style-type: none"> • Ensure voluntary character of involvement • Good communication • Good organization • Organize participation • Meeting of different practitioners • Invite influential, well-networked experts • Have experts comment on different case examples • Give control through emphasizing preliminary character of ideas • Present attractive propositions • Demonstrate expertise and process competence • Fresh perspective, outside view • Creative propositions • Critical design proposition • Creative attitude • Involve people regardless of rank • Inclusion as a source for novel ideas and a means to generate support |
| Hmelo-Silver, C. E., & Barrows, H. S. (2006). Goals and strategies of a problem-based learning facilitator. <i>Interdisciplinary Journal of Problem-Based Learning</i> , 1(1), 4. | Educational Research | <ul style="list-style-type: none"> • Use of open-ended and metacognitive questioning • Summarizing • Generate/evaluate hypotheses • Map between symptoms and hypotheses • Check consensus that whiteboard reflects discussion • Cleaning up the board |

| | | |
|---|----------------------|--|
| | | <ul style="list-style-type: none"> • Creating learning issues • Encourage construction of visual representation |
| Salinitri, F. D., Wilhelm, S. M., & Crabtree, B. L. (2015). Facilitating facilitators: Enhancing PBL through a structured facilitator development program. <i>Interdisciplinary Journal of Problem-Based Learning</i> , 9(1), 11. | Educational Research | <ul style="list-style-type: none"> • Fosters a collaborative learning environment with free discourses, which encourages sharing of knowledge • Scaffolding to develop students' knowledge acquisition and problem-solving skills beyond their current ability • Allows learners to take ownership of learning process • Challenges learners to interpret alternative perspectives and solutions • Stimulates self-awareness of learning process through metacognitive questioning |
| Jusoh, A. J., Isa, N. J. M., & Razali, M. M. S. M. (2015). Problem-Based Learning: Mandatory Personal Qualities of Effective Facilitators. <i>International Journal of Learning, Teaching and Educational Research</i> , 13(2). | Educational Research | <ul style="list-style-type: none"> • Understand the nature, goals, limitations, and advantages of the controlled group • Understand the different levels of understanding that exist in a particular group • Train and practice leadership skills such as providing feedback, drawing out, cutting off, spinning off, linking, modelling, and using eyes and tone of voice to encourage all members • Understand and pay attention to verbal or nonverbal elements • Comfortable in their roles and have knowledge about the topic of discussion, all while being patient, flexible, friendly, and open-minded • Realize the challenges that come with leading a group |
| Azadegan, A., & Kolfshoten, G. (2014). An assessment framework for practicing facilitator. <i>Group Decision and Negotiation</i> , 23(5), 1013-1045. | Management Research | <p>International Association of Facilitators competency model</p> <ul style="list-style-type: none"> • Create collaborative client relationships • Plan appropriate group processes • Create and sustain a participatory environment • Guide group to appropriate and useful outcomes • Build and maintain professional knowledge • Model positive professional attitude <p>Facilitation Service Assessment Framework</p> |

| | | |
|---|---------------------|---|
| | | <ul style="list-style-type: none">• Effective multi-session management• Preparing time/space to support group processes• Effective participation and interpersonal communication skills• Diversity recognition and ensuring inclusiveness• Group conflict management• Evoking group creativity• Facilitate group self-awareness about the task• Guide the group to consensus and desired outcome• Act with integrity• Trust group potential and model neutrality |
| Kolb, J. A., Jin, S., & Hoon Song, J. (2008). A model of small group facilitator competencies. <i>Performance Improvement Quarterly</i> , 21(2), 119-133. | Management Research | <ul style="list-style-type: none">• Helps with purpose and ground rules• Listens actively• Observes nonverbals• Uses questions skillfully• Creates a supportive climate• Encourages group involvement• Handles disruptive individuals• Adheres to ground rules• Plans the meeting and completes necessary follow-up• Professional ethics |

Based on these frameworks, we categorized and identified essential components for a design thinking expert mental model. In Figure 1, we illustrate our initial design thinking expert mental model.

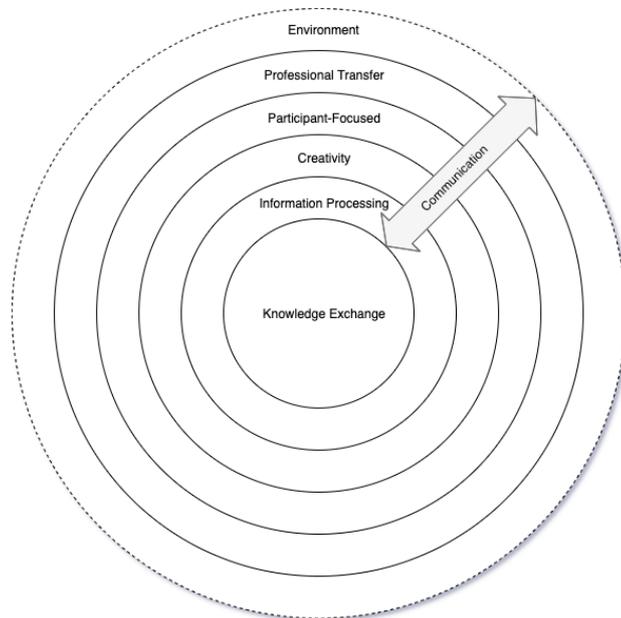


Figure 1 Initial Design Thinking Expert Mental Model

Our design thinking expert mental model consists of six components including a cross-cutting communication component. At the core of our model are the components of knowledge exchange and information processing. As previously argued, knowledge exchange and information processing involve important cognitive and metacognitive processes. In a dynamic problem-solving environment like design thinking, it is essential for a design thinking expert facilitator to possess these cognitive and metacognitive processes. The next component is creativity, which is necessary to solve problems considered difficult to solve (Lloyd, 2013). There is already much research about the need for design thinking facilitators to create heightened creativity and think outside of the box (Darbellay, Moody, & Lubart, 2017). There is evidence that design thinking facilitators, who positively increase the creativity in a design thinking environment, develop better prototypes that solve difficult problems (Tschimmel, 2012). Participant-focused, the fourth component, requires a design thinking expert facilitator to adapt and understand that the participants are the focus in a design thinking environment. Design thinking is considered to be a user-centric approach to problem-solving (Schallmo et al., 2018). Therefore, we argue that design thinking expert facilitators should make their design thinking participants their focus in the design thinking environment (Thoring & Müller, 2011). Design thinking facilitators, who are considered experts, tend to accept the dynamic nature of a design thinking environment, and their increased adaptability increases the chances of developing a suitable prototype (Sato et al., 2010). The fifth component is professional transfer, which highlights the importance of developing a prototype that solves a real-world problem. The sixth component, environment, focuses on the environment in which the design thinking activities take place but also how and where the prototype will be implemented. The final cross-cutting component, communication, highlights the importance of proper communication actions from the design thinking expert that are necessary throughout the

design thinking initiative. These results confirm that a design thinking mental model should contain the above-mentioned components.

Based on the proposed theoretical deficiencies, our study attempts to build a design thinking mental model based on design thinking experts. It is also important to distinguish principles between design thinking facilitators who are considered experts and those who are novices. Tavella and Papadopoulos (2015) contributed an important study to help identify the differences in characteristics between expert and novice facilitators. Table 2 presents these differences (Tavella & Papadopoulos, 2015).

Table 2 Expert versus Novice Facilitators

| <i>Expert facilitators</i> | <i>Novice facilitators</i> |
|---|---|
| See behind theories | Accept theories at face value |
| Modify and assess tools and techniques | Use tools and techniques as rules to follow |
| Engage in more sophisticated verbal interactions and appreciate subtle messages | More limited in their language and ability to draw inferences |
| Appreciate the value and meaning of features of situation | Treat data about specific contexts and situations more straightforwardly |
| Have more experiences to draw upon and cognitive and metacognitive abilities to take advantage of | Have fewer experiences to draw upon and cognitive and metacognitive abilities to take advantage of |
| Are more embedded in a culture and aware of the societal and organizational norms that influence their behavior | Are less embedded in a culture and aware of the societal and organizational norms that influence their behavior |

Based on their results, we can see some clear differences between expert and novice facilitators. We argue that expert design thinking facilitators must consider the following principles: 1) going beyond just presenting the theoretical foundation; 2) modifying and evaluating their learning curriculum, tool, and teaching techniques; 3) possessing the expertise in the target field or having a network of experts who can teach the target field; 4) having emotional intelligence; 5) having appropriate cognitive and metacognitive processes; and 6) creating an engaging knowledge exchange.

4 Conceptual Methodological Framework

We will need a rigorous research methodology strategy to begin to develop our design thinking expert mental model. As we are attempting to develop an artifact (i.e., model), we propose using design science (DS) as our research methodology. DS is an ideal research methodology to develop a mental model (Wieringa, 2014; Dolak, Uebernickel, & Brenner, 2013) because of its encouragement to use multiple research methods (Hevner et al., 2004).

Design-based research (DBR) shares several similarities with DS and has been a popular approach in educational research (Barab & Squire, 2004). Zheng (2015) conducted a thorough investigation of DBR from 2004 to 2013 using a systematic literature review (SLR). An SLR is considered one of the essential parts of the DS research methodology (DSRM). In our conceptual framework, we argue that DS is an appropriate research methodology to develop our DS expert mental model. We ultimately decided to use DS as our research methodological foundation because of its focus on developing models that address both academic and practitioner-oriented problems. The research procedure is based on Peffers et al.'s (2007) DSRM, which involves the following phases: 1) identify problem and motivation, 2) define objectives and solutions, 3) design and develop, 4) demonstration, and 5) evaluation. In Figure 2, the Information Systems Research Framework (Hevner & Chatterjee, 2010), based on DS principles, illustrates the importance of DS to develop relevant, academic and practical artifacts with high rigor.

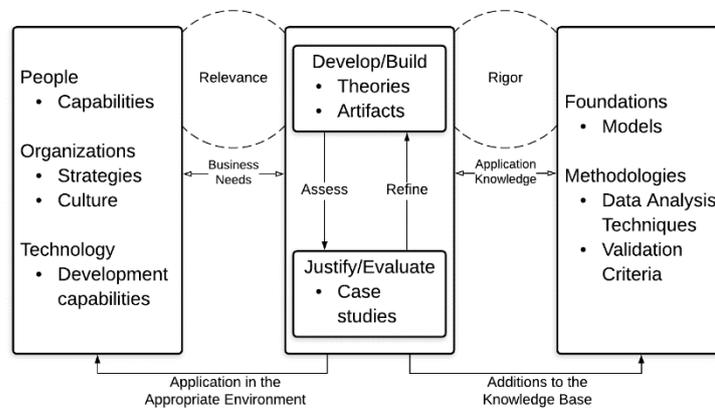


Figure 2 Information Systems Research Framework

The core of the design thinking expert mental model is dealing with a person's ability to exchange knowledge. In educational research, think-aloud protocols and cognitive interviews are well-established research methods used to investigate a person's cognitive and metacognitive processes (Wolcott & Lobczowski, 2020). According to Leighton (2017), "the purpose of having participants think aloud is to provide the investigator with the means to identify the thoughts and/or cognitive processes and strategies the participants experience in response to question or in the course of problem-solving specific tasks" (pg. 11). Leighton stated that "think-aloud interview procedures proper are used to measure problem-solving processes in working-in particular, problem solving that is novel and dynamic, involving the manipulation and transformation of information" (pg. 21). In contrast to think-aloud interviews, cognitive interviews focus on measuring a person's comprehension and understanding processes (Leighton, 2017). Figure 3 illustrates the measurement objectives of think-aloud and cognitive interviews.

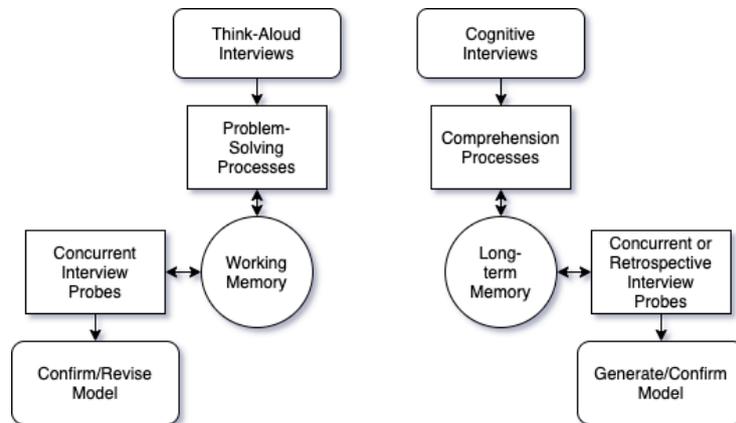


Figure 3 Think-Aloud and Cognitive Measurement Objectives (Leighton, 2017)

There is some evidence of the importance of using think-aloud interviews to assess managers in problem-solving situations (Isenberg, 1986). Think-aloud interviews have been used in management studies to investigate mental models of decision-making processes (Gavirneni & Isen, 2010) in entrepreneurs (Dew, Read, Sarasvathy, & Wiltbank, 2009), venture capitalists (Hall & Hofer, 1993), and expert-novice comparison of organizational design (Lee & Puranam, 2015).

Our previous work with metacognitive processes in learning environments has already shown great potential. In our previous work, the Co-Regulation Competencies Questionnaire (CRCQ) was developed and tested to measure metacognitive processes in learning environments (Williams, Seufert, Weinberger, 2017; Backer et al., 2018). In the first CRCQ study, the participants ($N = 212$) were between 18 and 74 years old ($M = 35.88$, $SD = 10.89$). The CRCQ contains 84 items and aims to measure learners' coregulatory competencies (i.e., metacognitive processes) by asking learners to assess *sharedness*. The study revealed that 15 out of 17 CRCQ scales had an $\alpha > .72$, which made us confident to use the questionnaire further with slight amendments. In the second study, participants ($N = 34$) were between 20 and 43 years old ($M = 27.56$, $SD = 6.00$). We have so far coded two groups based on our multidimensional framework for coding coregulation. The raters were trained (Vogel and Weinberger, 2018) and obtained a significantly high level of agreement with a kappa of above .95. The results show the potential of measuring perceived willingness to share/positive impression. We believe that this study shows potential to investigate the design thinking participants and their metacognitive processes. Based on these findings, we are convinced that our CRCQ, our multidimensional coding framework, and the proposed think-aloud and cognitive interviews are reliable novel quantitative and qualitative research methods to develop a design thinking expert mental model and contribute to innovation management research. We assert that the CRCQ has potential to measure metacognitive processes in a design thinking environment.

In Table 3, based on the DSRM (Hevner et al., 2004), we outline our conceptual methodological framework to develop our design thinking expert mental model.

Table 3 Conceptual Methodological Framework

| <i>DSRM Phases</i> | | <i>Description</i> |
|--------------------|---------------------------------|--|
| 1 | Identify problem and motivation | In this paper, we have outlined the research problem and value of such a mental model. In the next step, we plan to conduct a more rigorous systematic literature review (SLR). |
| 2 | Define objectives and solutions | The objective is to develop a design thinking expert mental model. |
| 3 | Design and develop | The initial mental model is developed using theory, but the next step would be to conduct a more rigorous literature review using SLR to revise our initial model. In the next iteration, we will use think-aloud and cognitive interviews to obtain empirical evidence and test our initial model's components. |
| 4 | Demonstration | The initial mental model will be presented to scholars and practitioners to assess its academic and practitioner value. |
| 5 | Evaluation | The mental model will be evaluated through peer-review publications and practitioner-oriented outlets. |

4 Academic and Practical Contributions

Our conceptual methodological framework including expert principles and an initial design thinking expert mental model contributes to the ever-growing design thinking literature. A further investigation would involve taking advantage of existing educational research methods to facilitate an interdisciplinary approach to innovation management. Our investigation would be among the first to combine educational research methods with innovation management concepts. This investigation would close additional existing research gaps in innovation management research by examining design thinking and knowledge exchange with an interdisciplinary research approach. Researchers and practitioners would greatly benefit from knowing in advance which participants would be better suited to a particular innovation management tool. Innovation management tools like design thinking require (high levels of) knowledge exchange, and one of the prerequisites of exchanging knowledge is sharing. Being able to better predict such outcomes and better manage innovation could provide valuable competitive advantages to companies and ecosystems.

5 Conclusion, Limitations, & Next Steps

In this paper, we proposed a design thinking expert mental model and conceptual methodological framework, which outlines essential mental model components and design thinking principles to help novice design thinking facilitators become better facilitators. Additionally, we outline a rigorous research methodology to further test and develop our mental model. We first explored the importance of agile practices to increase innovation in companies and discussed how innovation management scholars must consider conducting more interdisciplinary research including innovation research methods. In the next section, we presented the theoretical background of and interest in agile practices, particularly design thinking, in both innovation management and educational research.

According to the DSRM (Peppers et al. 2007), the proposed first next step would be to conduct an SLR to confirm the research gaps identified in this paper in the fields of design, education, and management. The proposed second next step would be to collect empirical data with think-aloud and cognitive interviews to test and further evaluate our initial design thinking expert mental model.

There were several limitations in this paper. First, our initial design thinking expert mental model is based purely on theoretical evidence. One of the planned activities is to collect empirical data to evaluate our initial model. Readers of this paper should be aware that, due to theoretical constraints and the lack of primary data sources, the presented results may not be generalizable. Furthermore, the outlined principles and proposed research methodology require further investigation.

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