That's a Good Question: Using Design Thinking to Foster Question Formulation Skill Development

AnneMarie Dorland, Mount Royal University, adorland@mtroyal.ca

Abstract. Design thinking is a critical and creative process understood to support innovation and creative idea generation in a wide variety of contexts. Increasingly, it is being used as a pedagogical approach by educators interested in supporting divergent thinking skill development. This study evaluated the effects of the use of design thinking practices on student learning within the context of the first-year post-secondary classroom. Analysis of student generated reflective statements and of in-class student work demonstrated that the use of design thinking practices may improve creative and critical thought and may enable students to achieve question-focused and divergent thinking-focused learning outcomes more easily. The core of all student learning is in asking strong and resonant questions—this study demonstrates that the inclusion of design thinking practices in an undergraduate learning community may foster the skills required to do this critical work.

Keywords: design thinking; divergent thinking; question formulation; inquiry

Students are trying to learn how to ask strong and divergent questions every day in each of their classroom engagements, but researchers interested in the scholarship of teaching and learning know well that this is an elusive and difficult skill set to develop in the course of in-class learning (Iverson, 2018). Instead, undergraduate students across disciplines often rely solely on convergent and solution-oriented question types, a heuristic that may limit their creative and critical thinking skill development (Goldschmidt, 2016). Instead of "how might we…?", they ask "how does it work?". Instead of "what would happen….?", they ask "what have I seen happen before?". The challenge for post-secondary instructors is to find a new model for fostering a robust question formulation practice: a new way of building a question-asking culture in our classrooms. In this paper, I suggest that a question-asking culture can be in a setting, namely the design studio, where a community of practitioners have developed the ability to generate new, creative, and critical thoughts in a reliable, repeatable manner within tight time and resource constraints using design thinking. Here, I propose that the practices of designers—design thinking—may serve as an effective model for instructors seeking to foster divergent and strong question-asking skills as a learning outcome for their students. Can design thinking help students learn how to ask stronger questions?

To explore this question, I worked with students to examine the ways in which design thinking practices could be used to improve the question formulation skills of undergraduate students enrolled in an interdisciplinary first-year course. I compared the impact of four methods of question formulation used in many higher education classrooms (group discussion, brainstorming, mind mapping, and case study analysis) with four methods of design thinking-based learning (ethnographic futures, shadowing, user experience journey mapping, and informance). My aim

was to better understand how the practices of design thinking may impact the development of a question-asking skill set among undergraduate learners and to explore the differences in the student experience of the two learning approaches.

Studies of the use of design thinking in the undergraduate classroom (Matthews & Wrigley, 2017), business settings (Kelly & Kelly, 2013), and the innovation development process (Beckman & Barry, 2007) have also shown that the use of a "designerly way of knowing and doing" (Cross, 2006) can have a strong positive impact on learning (Henriksen et al., 2017). In their work on the impact of teaching design thinking in business schools, researchers from Boise State University have demonstrated the effectiveness of the use of design thinking as a part of curriculum at the undergraduate level, suggesting that design thinking-based learning may present a powerful framework for dealing with "unstructured problems and for managing the innovation process" (Glen et al., 2015). Design thinking is becoming an ever more vital part of post-secondary education (Charosky et al., 2018) from the classroom to the massive open online course setting (Wrigley et al., 2018).

My expectation that the use of design thinking practices may lead to the development of stronger or more divergent student questions is informed by design theorist Lucy Suchman's (2011) analogy of "navigating" and "wayfinding" as two different approaches toward creating new ideas or new forms of knowledge. We anticipated that students would apply a wayfinding approach to developing questions during the design thinking-informed phase of their work—and that this approach would help further develop their strong or divergent question-asking skills.

This study of student learning and the impact of design thinking practices on divergent thinking focused learning outcomes is rooted in the particular local context (Huber & Hutchings, 2005) of the interdisciplinary, first-year undergraduate seminar classroom, and not of the design studio. As such, it provides a new perspective into the use of a design thinking-based learning approaches in an undergraduate research class. Many investigations of the use of design thinking practices examine the use of the five-stage process in corporate brand, product, and strategy development work (IDEO, 2019). In this paper, I present findings from research conducted in partnership with student participants (Earley, 2014; Winn, 1995) that explores what happens when educators use design thinking to help in the first stages of creating new thoughts and questions. Specifically, I ask this question: Do design thinking practices help students learn to ask better questions?

This microlevel examination (Williams et al., 2013) of the use of design thinking in the development of "ideamaking" (Resnick, 2017) presents evidence which suggests that design thinking-informed approaches, such as ethnographic futures; shadowing and participant observation; user experience journey mapping; and informance may help students develop the skills they need to ask strong and divergent questions during the research process. Data collected from reflective statements generated after two phases of in-class work indicates that students can learn to ask stronger and more divergent questions by using design thinking-

oriented learning strategies to support what Resnick (2017) defines as a playground, rather than a playpen, classroom environment.

Overview

Design Thinking

The practice of design thinking, a general term used often to describe the work of connecting creativity and innovation within an integrative series of divergent and convergent social practices, has grown exponentially since its conception in the systems engineering world of the 1960s and popularization in the fields of business in the earlier part of this century (Brown, 2008). Increasingly, design thinking (framed as a practice, protocol, or mindset) is being applied as a problem-solving heuristic in fields as diverse as K-12 education (Samberg, 2018), health care (Roberts et al., 2016), and industry (Wrigley et al., 2020). Design thinking is most often understood as an iterative and cyclical series of divergent and convergent stages through which individuals and teams can effectively solve human centered problems (Dorst & Cross, 2001). As Tschimmel and Santos (2018) have suggested, effective use of design thinking processes and protocols relies on the designer's ability to simultaneously consider human needs, the available resources, and the constraints and opportunities of a presented challenge. Most commonly, this is achieved through team based and participatory protocol or process exercises grouped into five main categories: empathy, problem definition, ideation, prototyping, and testing (Cross, 2011). Design thinking is most effectively understood as a tested and established approach to metacognition: a process of designing how one thinks about human-centered challenges and needs and of deliberately engaging in the practice of mental ambidexterity aimed at shifting reasoning and sensemaking practices within a culture of changemakers (Dorland, 2018).

Question Asking and Design Thinking

Questions form the heart of the research process in any academic environment, but they are also the distinguishing feature of design thinking. However, the development of a robust question-asking skill set remains a challenge in teaching and learning. As Rothstein et al. (2015) have identified, learning to ask the right question is critical for student learning in the undergraduate setting—so critical that it has been listed as the foundation of 6 of the 10 "future skills" in the World Economic Forum's *Future of Jobs Report* (2018) and as key components of the majority of high impact practices proposed by Kuh (2008). Minigan and Beer's (2017) work on the Question Formulation Technique in higher education indicated that developing strong and divergent question forms remains an area of weakness in the undergraduate learning community. Hassi and Laasko (2011) have suggested that within a learning community where questions are often discouraged, individuals at any level of expertise may rely heavily on solution finding, rather than question asking, activities. The role of evaluation and feedback has also been discussed by the educational development team at IDEO, who outlined the impact

that a reliance on summative evaluation practices can have on the development of question-asking skills (IDEOU, 2019).

Addressing the Development of a Question-Asking Skill Set Using Design Thinking

The use of design thinking-based learning approaches in the undergraduate classroom may provide a new and effective way to support students in the development of their question-asking skills. Firstly, design thinking-based learning approaches may be more conducive to question asking than other research processes. As Helfand (2016) has illustrated in her work on design communities, the ability to generate divergent and convergent thought while diving ever deeper into the question-asking process is the critical skill of the designer—one which might be translated to the classroom through design thinking-based learning processes. In fact, members of design communities have reported that learning to ask questions about how a thing might be done or what possibilities arise from a unique situation is both the most critical and the most challenging part of their creative and cultural production work (Dorland, 2018). The ability to develop strong questions and to remain "curious" (Brown, 2008) for extended periods of time enables designers to generate more creative, innovative, and authentic solutions to critical social and cultural challenges (Dorland, 2018). Research conducted in undergraduate studio courses suggests that design thinking practices such as those employed in this study may be key to establishing the development of creative and critical thought in student communities as well (Rashdan, 2017).

Secondly, the use of design thinking-based learning practices may support the use of play in the development of a meaningful question-asking practice. In his work on divergent thinking processes, Resnick (2017) proposes that aspects of creative and critical thought—or the making, rather than the getting, of ideas—are premised on four key elements, each of which can be enhanced in the learning experience. Projects (or the iterative development of an idea towards a goal) provide students with a required point of focus; passion (or the alignment of learning activities with learner interest) fuels the collaborative work of a classroom; and peers provide and support reflection and reflection-in practice (Schön, 1983). Most interestingly, he also suggests that what is most often left unconsidered in the higher education classroom space is play: the deliberate implementation of opportunities to explore ideas and directions of thought. Resnick identifies two models that can support the critical and creative thinking fostered by play: the "playpen" and the "playground." Playpens, according to Resnick, provide opportunity for limited and bounded creativity and can be supportive and generative while employing clear boundaries for playful thought. The playground, on the other hand, is an analogy for an experimental space where students are able to develop and nurture their creative and critical thinking practices (Resnick, 2017).

Brown (2008) has also argued that design thinking practices, whether deployed in the studio space, the boardroom, or the classroom, are supportive of exactly this type of play-informed creative and experimental learning process. Additionally, he suggests that design thinking practices may contribute towards a better understanding of psychologist Joy Paul Guilford's (1967) foundational work on

convergent thinking and divergent thinking. As Guillford outlined, creative thought is reliant on both convergent and divergent thinking practices—without the balance between the two students would be unable to make use of a question-asking skill set in their innovation focused work. Student's convergent thinking practices may already be well supported: research suggest that it is incumbent on educators to foster skills in divergent processes of thought instead (Briggs, 2014).

The Study

Purpose

My motivation for undertaking this study of student learning was threefold. First, I am a design practitioner and researcher interested in the application of studio-based creative problem-solving strategies in the higher education classroom. Secondly, a review of the literature outlining evidence about the impact of design thinking practices in generating innovative or critical thought surfaced little on the impact of these practices in understandings of student learning. Finally, key learning objectives in the course that formed the grounding for this study included fostering and developing an understanding of the research process for students and enhancing the skills required for students to develop a research practice. As such, students were welcomed as collaborators on the data collection and analysis phases of this study whenever possible. This study assesses student experiences of design thinking-focused learning strategies by analyzing their reflections on how design thinking practices might bolster or strengthen the questioning skills that are so critical to the undergraduate learning experience. This work is guided by the following research questions:

1. Do participating students ask questions in a different way after engaging with design thinking practice during an interdisciplinary undergraduate course?

2. How is the student's learning experience affected by the use of design thinking-based learning approaches?

This study contributes to addressing a gap in the literature on both student learning and creativity, especially with respect to new options for using design thinking as a tool for research practice and critical thinking at the undergraduate level. Though this study examined the use of design thinking in a group learning and undergraduate context, the evidence generated and analyzed in partnership with student learners presents potential new areas of exploration that can be taken up by Scholarship of Teaching and Learning (SoTL) researchers interested in individual research practice skill development and the development of creative and critical thought in experiential learning environments.

Methods

In asking how the use of design thinking-based learning approaches affected the student's question formulation processes, I chose an approach that allowed for the inclusion of student participants into all aspects of the research process (Felten et

al., 2013; Hutchings, 2000), including data generation and analysis. Using a collaborative approach that incorporated student learners as research partners allowed us all to focus on considerations of learning as a lived practice engaged within a community that included both instructor and student members (Lave & Wenger, 1991). This methodological approach in both data collection and analysis was aimed at generating "thick" descriptions based on "being there" (Borneman & Hammoudi, 2009), a goal that would have been impossible to realize without the collaborative input of student participants.

Participants

For the purposes of this study, I collected data in from two sections of a first- year, interdisciplinary, and inquiry-based course at a large research-focused Canadian University. The sample was made of two relatively small classes (with fewer than 30 enrolled students per section), and 95% of students in each section consented to participate and to include their work as part of the data set (n = 37). Students who did not chose to consent to participate in the project (n = 2) were able to expunge their class work from the final data set (including their reflective statements and question samples) and to debrief their experience individually with the course instructor.

The classes met twice a week for a 90-minute course focused on developing a personal research practice. The course context that forms the basis for this study was open to any student with less than one year of course credit at the institution (regardless of major, GPA, or faculty designation). Students came from eight disciplines of study and were enrolled in the faculties of arts, engineering, science, education, social work, and kinesiology. All participants in this study self-identified as first-year undergraduate students aged 17–23, and the course that provided the context for this study was taken during their first term of study at the university. This is especially important because this meant that student participants were engaging with some of these learning outcomes and learning practices for the first time and were participating in research on their own learning for the first time as well. The instructor for this course taught both sections included in this study and brought a background in qualitative research and design practice to their work as a facilitator and guide for student learning.

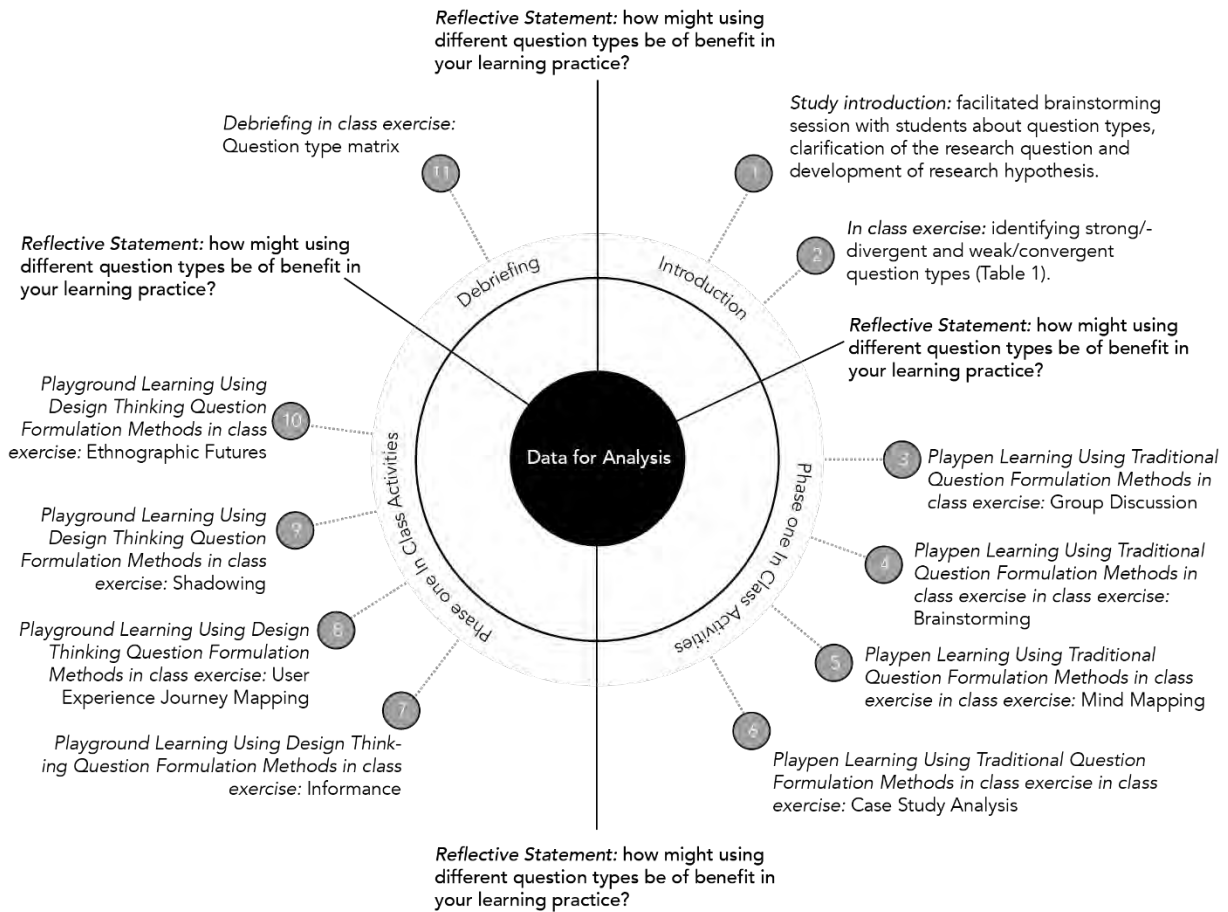## Procedure and Data collection

Data was collected during 12 observation opportunities for each section of the course (with a total of 24 observation opportunities). The data generated by both course sections was combined for the purposes of analysis, and the amalgamated data set is presented and discussed below. Student participants in this study were recruited by a research assistant with no connection to class work or course evaluation during the first day of class. They were given the opportunity to review the study protocol, the Conjoint Faculties Research Ethics Board (CFREB) ethics approval statement, and the study's alignment with the learning outcomes of the class and discuss the details of participation with the research assistant. Informed consent for participation was granted by students after this initial briefing session

with the research assistant and re-confirmed at the end of the study prior to the final debriefing session.

The process of doing this project in the classroom is outlined in figure 1 below.

Figure 1

Study Timeline and In Class Exercise Protocol

Reflective Statement: how might using different question types be of benefit in your learning practice?

Debriefing in class exercise: Question type matrix

Study introduction: facilitated brainstorming session with students about question types, clarification of the research question and development of research hypothesis.

Reflective Statement: how might using different question types be of benefit in your learning practice?

In class exercise: identifying strong/-divergent and weak/convergent question types (Table 1).

Reflective Statement: how might using different question types be of benefit in your learning practice?

Playground Learning Using Design Thinking Question Formulation Methods in class exercise: Ethnographic Futures

Playground Learning Using Design Thinking Question Formulation Methods in class exercise: Shadowing

Playground Learning Using Design Thinking Question Formulation Methods in class exercise: User Experience Journey Mapping

Playground Learning Using Design Thinking Question Formulation Methods in class exercise: Informance

Debriefing

Introduction

Phase one In Class Activities

Phase one In Class Activities

Data for Analysis

Playpen Learning Using Traditional Question Formulation Methods in class exercise: Group Discussion

Playpen Learning Using Traditional Question Formulation Methods in class exercise in class exercise: Brainstorming

Playpen Learning Using Traditional Question Formulation Methods in class exercise in class exercise: Mind Mapping

Playpen Learning Using Traditional Question Formulation Methods in class exercise in class exercise: Case Study Analysis

Reflective Statement: how might using different question types be of benefit in your learning practice?

In this class, students were working on developing a research program in support of innovation. They were tasked with working in groups to research a challenge area (for example, new forms of climate friendly farming) and to use their research to generate an idea for an innovation that would address the challenge area in a meaningful way. The final assignment for this class was a research poster, a written essay, and a public innovation presentation.

I began this study by collaborating with students on a baseline definition of a "strong or divergent question." During the first week of class, students participated in a facilitated exercise where they identified the characteristics of "strong or divergent" and "weak or convergent" questions (as outlined in Table 1, below). This guiding taxonomy of strong and weak question types was then made available to

students for their use on the course management platform (and was referred to during course work throughout the rest of the term). After this facilitated exercise, students were prompted in their course management platform to write a brief reflective statement (>200 words) about how asking strong and divergent questions may be of benefit in their learning practice.

Table 1

Student Generated Taxonomy of Weak/Convergent and Strong/Divergent Question Types

Question type	Weak/Convergent questions	Strong/Divergent questions
Row 1	Easily solved.	Are difficult to solve.
Row 2	Are answered based on my prior knowledge.	Require new experiences for me to answer them.
Row 3	Have answers that don't generate more questions.	Breed new questions for me to think about.
Row 4	Don't make me think.	Make me think about new things.
Row 5	Aren't very interesting to others.	Are interesting to others.
Row 6	Lump things together.	Blow things apart.

Phase One: Playpen Learning Using Traditional Question Formulation Methods

Students then spent the next four class sessions (two weeks of course time) engaging in facilitated group discussions aimed at generating question statements that they could use in their research on the common course project. This portion of the study was defined as the "playpen" phase. These facilitated discussions employed the following traditional (non-design thinking oriented) strategies of question generation:

1. Group discussion
2. Brainstorming/mind mapping
3. Research using secondary sources of peer reviewed scholarship
4. Discussion based case study analysis

In each of the sessions, students were grouped in small teams of five team members or less and were tasked with generating questions that they felt would guide their research process moving forward. Questions were tracked by writing them on sticky tabs coded numerically for future categorization and all generated questions were collected at the end of the session, transcribed to a shared document posted on the course management platform, and kept for debriefing at

the end of the project. At the end of these four sessions, students were prompted in their course management platform to write a brief reflective statement (>200 words) on their experience of generating guiding questions for researching the common class project using the traditional (non-design thinking) strategies deployed in this phase of the course work.

Phase Two: Playground Learning Using Design Thinking Question Formulation Methods

Students then spent time in the next four classes working with design thinking methods to generate question statements. This phase of the work required additional work on behalf of the course instructor and the students as many of the design thinking methods engaged in this phase required adapting to new skills and approaches as part of the research process. This portion of the study was defined as the "playground" phase. Questions were tracked in the same manner as phase one (with sticky tabs coded using numeric indicators) and transcribed for use during debriefing in a common document. This second set of four facilitated sessions employed the following strategies to help students generate guiding questions for the common class project:

1. Ethnographic future studies (wherein students used samples of media representations of the future to conduct desk-based hypothetical ethnographies of future states and to generate new questions about what might be possible in that future).

2. Shadowing (whereby students embedded within a social setting of their choice to develop an understanding of a different context and to generate questions from the point of view of a different person with a different perspective than their own).

3. User experience journey mapping (wherein students mapped the experience of a subject involved in a possible solution to the class project to generate questions that the subject might pose at any given intersection on their journey).

4. Informance (whereby students studied a social practice and then used performance to share that social practice with team members who asked new kinds of questions about the performance itself).

At the end of these four sessions, students were again prompted in their course management platform to write a brief reflective statement (>200 words) on their experience of generating guiding questions for researching the common class project using the strategies deployed in this phase of the work.

In order to debrief the study findings and to engage students in further collaboration on this study, student participants did a sorting exercise of all questions generated in phase one (playpen) and phase two (playground) classes, using a matrixed version of the original taxonomy of strong/divergent and weak/convergent question types generated at the beginning of the study. Students

worked with their peers to place the question sticky tabs on the large wall sized matrix in a way that would indicate their placement on the continuum of strong/divergent to weak/convergent question forms using the particulars of each type identified in the taxonomy. Students were not able to see whether the questions had been generated during the first or second phase of the project during this sorting exercise, and the questions used were not sorted into teams or groups (and were rather compiled as one common pool or selection). A class discussion followed which provided an opportunity to contextualize study findings, member check the conclusions drawn by the principal investigator, and identify areas of future research or study limitations in collaboration with the student participants. Finally, students met separately with a research assistant who conducted a group discussion focused on the research questions identified at the beginning of the study, and the student's self-evaluation of their question formulation skill development. At this informal gathering, students were also invited to share their experience with the different learning practices employed during both phase one and phase two of the study. The research assistant also shared results of their sorting exercise with students at this time.

Data Analysis

After the collaborative data collection work was finalized, I used qualitative content analysis to derive coding categories directly from the collected and transcribed data (Braun & Clarke, 2006; Hsieh & Shannon, 2005). To do so, we—the principal investigator and a research assistant—read the data broadly as a whole to develop a contextual understanding of the student perspective. I then employed thematic content analysis to examine the data for commonalities in order to better understand the student experience of phase one and two of the study and to generate coding categories.

Initial coding categories developed from this close reading were then shared on the course management platform with student participants as a form of member checking. One coding category was adjusted for clarity based on the feedback shared by students. All other coding categories were found to be well aligned with the responding student's experience of their learning in class. Data collected through the reflective statements and the student-generated question strength continuum was then analyzed by the principal investigator using qualitative data analysis software. To establish intercoder reliability, a blind sample of data was then recoded by a research assistant. The intercoder reliability was 93%, providing additional validation to the coding scheme.

Findings

This study explores student experiences of design thinking-focused learning strategies and their reflections on how the design thinking practices originating in the creative studio might bolster or strengthen their questioning skills. The following research questions formed the foundation for this research:

1. Do participating students ask questions in a different way after engaging with design thinking practice during an interdisciplinary undergraduate course?
2. How is the student's learning experience affected by the use of design thinking-based learning approaches?

Coding of the reflective statements generated after in class work during both the playpen (first) and playground (second) phases of the study (n = 74) generated the themes listed below. There was no indicated difference between common and uncommon themes in the analysis process. Themes included

1. Producing unexpected or new directions for further research
2. Generating possible solutions to the larger class project
3. Contextualizing or exploring the larger class project
4. Decoding or evaluating thinking processes
5. Testing possible solutions to the larger class project
6. Uncovering assumptions or gaps in knowledge
7. Building on pre-existing knowledge basis
8. Drawing from the lived experiences of others
9. Identifying unknown particulars of the larger class project

Phase One: Playpen Learning Using Traditional Question Formulation Methods

The number of reflective statements generated using "playpen" learning strategies (group discussion, brainstorming or mind mapping, secondary peer reviewed research, and case studies) that included content related to each theme is outlined below in Table 2. Student-generated reflective statements often corresponded to more than one thematic code, though that was not always the case. In this phase of the study, most students reflected on the facets of the larger class project that were unfamiliar or unknown. Eighteen student participants discussed the complexities of identifying unknown particulars of the larger project as the key contribution of their question-asking process.

One student participant commented on the theme of *identifying unknown particulars of the larger class project*:

> Doing questions through the group work helped me understand more about the bigger challenge and now I know what I need to research more about. I didn't understand the bits involved and now it is coming together. (Student 6)

Other students (68%) focused their reflections on the way that asking questions through group discussion and brainstorming (or mind mapping) helped them build on their preexisting knowledge basis. In particular, students reflected on the

commonalities of their experience and knowledge and the complexities of the class project:

> I asked questions about how this is the same as some of the things we do because the things we do aren't all that different than what's happening in the rest of the world. Everyone is the same and if we just ask questions about things we can understand then we can find what we have in common and use that to create a good solution. (Student 14)

A common theme in student reflections generated after the four classes in which they developed questions through group discussion, brainstorming or mind mapping, the use of secondary peer reviewed research, and case studies was the overwhelming nature of questions themselves and the tendency of questions to prompt unexpected or new directions for further research. One of the 23 participants who reflected on this theme noted the following:

> You ask a good question but you can't just use that. A question just makes everyone else in the group go off in a new direction and you can't bring it back to what you are supposed to be thinking about. Having a group for this part was hard and having to jump in with more questions everyday just confused us (Student 19)

Table 2

Thematic Analysis of Phase One Reflective Statement Responses

Variable	Thematic categories	N	%
Row 1	Drawing from the lived experiences of others	1	0.03%
Row 2	Decoding or evaluating thinking processes	2	0.5%
Row 3	Uncovering assumptions or gaps in knowledge	4	1.0%
Row 4	Producing unexpected or new directions for further research	5	13.5%
Row 5	Testing possible solutions to the larger class project	13	35.1%
Row 6	Contextualizing or exploring the larger class project	17	45.9%
Row 7	Identifying unknown particulars of the larger class project	23	62.1%
Row 8	Building on pre-existing knowledge basis	25	67.5%
Row 9	Generating possible solutions to the larger class project	29	78.3%

Phase Two: Playground Learning Using Design Thinking Question Formulation Methods

The number of reflective statements using the design thinking-based learning strategies (ethnographic future studies, shadowing and participant observation, user experience journey mapping, and informance) that included content related to

each theme is outlined below in Table 3. Again, student-generated reflective statements often corresponded to more than one thematic code, though that was not always the case. Two student-generated reflective statements did not correspond to any of the identified themes.

Table 3

Thematic Analysis of Phase Two Reflective Statement Responses

Variable	Theme	N	%
Row 1	Generating possible solutions to the larger class project	7	18.9%
Row 2	Decoding or evaluating thinking processes	11	29.7%
Row 3	Building on pre-existing knowledge basis	14	37.8%
Row 4	Contextualizing or exploring the larger class project	16	43.2%
Row 5	Testing possible solutions to the larger class project	19	51.3%
Row 6	Producing unexpected or new directions for further research	23	62.1%
Row 7	Uncovering assumptions or gaps in knowledge	24	64.8%
Row 8	Identifying unknown particulars of the larger class project	27	72.9%
Row 9	Drawing from the lived experiences of others	30	81.0%

In this second phase of the study, far more reflective statements focused on the importance of drawing on the lived experience of others as key in their question generating process (77%). In these statements, students reflected on the role of moving outside of their own knowledge base and their own context to learn more about the complexities of the larger class project from the point of view of others, and 21 students mentioned "getting outside your own bubble" or "leaving your comfort zone" as part of developing a strong or divergent question.

> I wasn't thinking of what questions to ask about how a solution might work before doing this part of the class. I was just thinking about what might work, but I can see more about impact now than I did then. (Student 3)

> There are lots of sides to the problem but we already knew more about that. I didn't really think of how many people or what kind of people were involved now and I'm asking more interesting questions now that I do. (Student 18)

Additionally, students reflected on the role of their questions in testing possible solutions and in evaluating their own thinking process. Fully half of all submitted statements included reflections on the role of using the questions generated at the beginning of the process to better understand the validity of the solution that they would propose at the end. One participant noted the following:

Without the good questions that came from the interview I wouldn't have a way to know if my proposal would work or not. Now I have something to navigate with. (Student 21)

Debriefing and Question Sorting Exercises

Some of the most interesting outcomes from this study came from the debriefing exercise that students completed after phases one and two of the collaborative data collection work. As mentioned above, students helped define the collective understanding of the role of design thinking practices in the question formulation process by generating a taxonomy of strong and weak question types (Table 1) at the beginning of the study. All enrolled students (n = 39) took part in the generation of this taxonomy during their class time.

This taxonomy was used in the debriefing exercise conducted after the collection and analysis of the phase one and phase two data. After a group discussion about the merits of convergent and divergent thinking practices students worked collaboratively to plot all of the questions generated during their in-class work onto a large 2 x 2 matrix, which is shared below. Questions generated during phase one of the study (using learning strategies such as group discussion, case studies, secondary peer reviewed research, and brainstorming or mind mapping) are indicated in Figure 1 below using a red dot. Questions generated using phase two of the study (using design thinking-focused learning strategies such as ethnographic future studies, shadowing and participant observation, user experience journey mapping, and informance) are indicated in Figure 1 using a blue dot. Students did not know which questions were generated during phase one and phase two of the study and placed questions onto the matrix based on their current interpretations of the question itself.

This matrix indicates that students were more likely to categorize questions generated during the "playpen" phase of the study as weak and convergent in nature (58% of total questions generated during phase one) and, conversely, more likely to categorize questions generated during the "playground" phase of the study as strong and divergent in nature (52% of total questions generated in phase two). Students debated the placement of each question in the matrix, with many landing in (as one participant described) the "in between zones" of divergent/weak questions (23%) and convergent/strong questions (18%). Fully 85% of the questions generated in the "playground" (with the learning strategies generated using design thinking) were categorized as strong, with either a divergent or a convergent focus.

As part of the debriefing process, students worked as a group to generate a representative question from each quadrant of the two by two matrix, as indicated in Figure 2 below.

One participant shared in the final reflective statement for the class that she completely revised her approach to both generating and using questions in her research work as a result of this sorting exercise:

I never thought about how I could make the question do the work when it came to setting my direction. I always used the questions that were clearest, but I think the ones I liked best and that I identified with were more the ones that led you in a million directions and made you think a little harder. (Student 12)

Figure 2

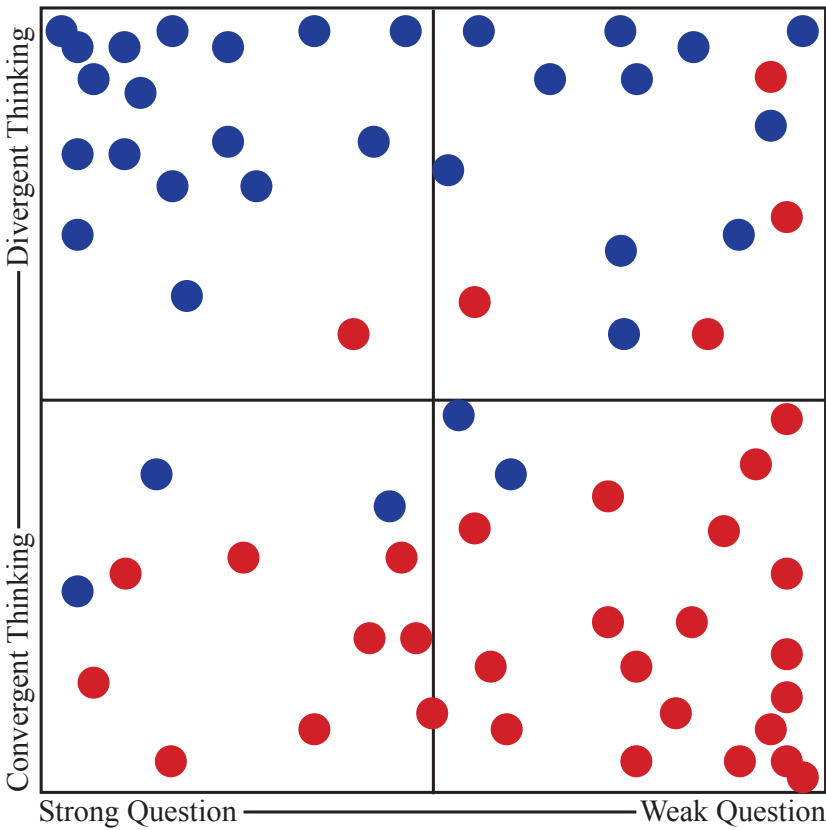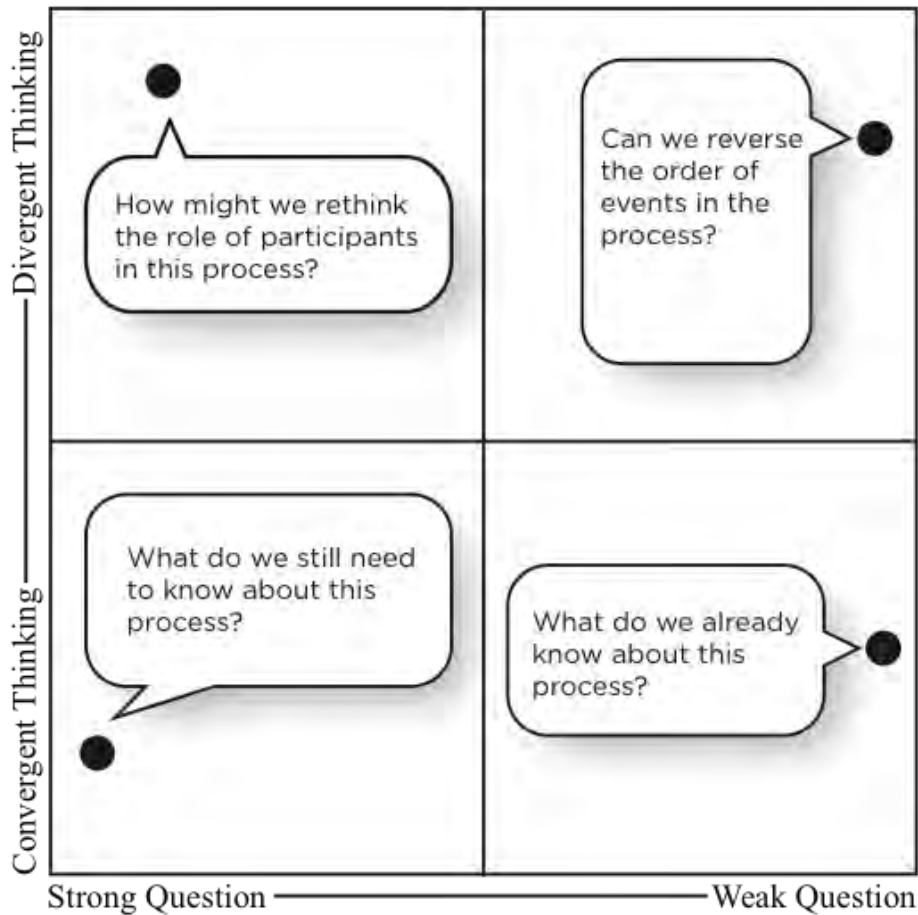*Student Generated Matrix of Question Types*

Figure 3

Student Generated Matrix of Question Types with Representative Questions

Discussion

This study examined whether students could learn to ask stronger and more divergent questions by using design thinking-oriented learning strategies to support what Resnick (2017) defines as a playground, rather than a playpen, classroom environment. I analyzed the differences and commonalities between reflective statements generated by student participants after engagement with what I defined as "playpen" learning strategies (including group discussion, case studies, secondary peer reviewed research, and brainstorming or mind mapping) and "playground" or design thinking-oriented learning strategies (including ethnographic future studies, shadowing and participant observation, user experience journey mapping, and informance). I asked how students defined strong/divergent versus weak/convergent question forms, how they experienced generating questions using different types of learning strategies, and how they understood their own work in relationship to divergent and convergent thinking paradigms after having reflected

upon different learning practices. The intent of this research was to better understand whether a "playground," or design thinking-oriented environment truly supported the development of creative and critical thinking skills in first year undergraduate learners.

The key findings about the impact of design thinking on this particular aspect of student learning can be grouped into two larger categories which align with the literature in the field of innovation and creativity (most notably the work of Guilford, 1967): convergent processes and divergent processes. First, the evidence suggests that the use of design thinking as a learning strategy supports and nurtures the development of divergent thinking approaches with respect to the activities of cognition, production, and evaluation. Secondly, the evidence suggests that the use of playpen (or limited creativity) learning strategies can still support the development of strong/divergent question forms but also formulates more convergent thinking practices among undergraduate students—increasing the solution determinacy of student efforts and decreasing the function of play as a form of exploration in the making of new ideas.

The majority of participating students reflected at least once (68%) upon the positive difference in their individual learning approaches after engaging with design thinking practices, which exemplifies the positive role such learning activities may play in the classroom. This suggests that after engaging with design thinking practices in their learning strategies, students might be asking questions in a different way—one that is perhaps more aligned with the high impact practices identified in the literature on student learning and creative practice (Kuh, 2008). One third of student reflections about their improved learning approaches also made reference to aspects of what Dweck (2008) has defined as a growth mindset: specifically, that they were developing knowledge over time and that they were learning more from failed question forms than from successful ones. I interpret this to mean that design thinking practices, when engaged as learning strategies, may have a positive effect on the development of a growth mindset in students.

What becomes evident in the examination of the matrix of question types and of the sample representative questions generated by students in the debriefing session is that students find divergent and strong/divergent questions to be especially generative for creative and critical thought—and that the use of design thinking learning strategies enabled the creation of those question forms. As Resnick (2017) identified, the critical and creative thinking generated through playground form play (in contrast to the limited opportunities for creativity found in playpen style play) supported more resonant and deeper expressions of student learning. The local context for this study was well grounded in the creative learning foundations identified by Resnick (2017): project, passion, and peer supports were strong/divergent and aligned with the group and inquiry-based learning approaches to the work students completed as a learning community. With that in mind, this findings from this study suggest that the integration of design thinking practices may be a critical variable in the development of strong and divergent question forms: using design thinking in the class appears to increase the playground, and decrease the playpen, aspects of play in creative learning.

How effective did students think design thinking methods were as a method of improving their question-asking abilities? In final reflective statement data, nearly two-thirds of the students reported that their strongest and most divergent questions came from the design thinking process, and many indicated the applicability of this process to other course work. My interpretation of this finding is that the learning strategies introduced through design thinking practices are transferable, useable, and well aligned with all forms of student inquiry, not just creative practice. Seventy-five percent of students reflected on the playful nature of the design thinking practices they encountered during the second phase of the study and on the freedom that these processes engendered. Additionally, 59% shared that their experience of the design thinking (or playground) practices used as learning strategies allowed them to take on additional points of view or diverse perspectives in order to generate new ideas or approaches to a problem. These two findings indicate to us that incorporating design thinking practices as learning strategies in the undergraduate classroom is both a positive student experience and a potential high impact practice in the development of citizenship and global perspective development.

Perhaps the most interesting aspect of the data that emerged after thematic analysis was the differentiation students made between the uses of questions in their future work. Design theorist Suchman (2011) refers to the use of "navigating" and "wayfinding" as helpful analogies to understand the differences identified in the students' reflections, and they are useful when examining the data presented here as well. In this study, students shared that a "navigating" approach to creating new ideas through question development required them to presuppose a solution and to plan a series of inquiries that will help them arrive at the designated result. On the other hand, students using a "wayfinding" approach to developing new thoughts or making new ideas instead relied on an iterative process of trial and error—on exploring the territory of the ideas in development rather than developing ideas in service of a solution. In this study, I saw students applying a wayfinding approach to developing questions during the "playground" phase of their work—an approach that, if nurtured, may be of benefit to students exploring the development of new ideas in more traditional learning environments.

Limitations

This study of whether the use of design thinking methods can help students ask better questions was limited in several ways. My hope is that with consideration of these limitations in mind instructors and faculty members may be able to find new ways to further examine this function of student learning in higher education.

First, student participants in this study came into their role with a preconceived awareness of the value of design thinking and the value of divergent thinking practices. Phrases like "thinking outside the box" and "thinking differently" formed a second level theme during the coding of the first round of reflective statements, indicating that students were prepared to value divergent practices more highly than convergent thinking methods. Additionally, the students' enthusiasm for the

learning strategies involved in phase two was markedly higher, which may have resulted in students placing a higher value on the questions formed using these tools. This is difficult to mitigate, as the active and experiential strategies associated with design thinking are, in this author's opinion, just more fun. With that in mind, it may be worthwhile to experiment with different pairings of learning strategies in future in order to work around this limitation in the data collected.

Secondly, due to the structure of the study, students may have been improving the strength of their questions in ways that could not be explained by the use of the design thinking practices. For example, students had already been familiarizing themselves with the larger class project for several weeks before tackling the second phase of learning strategies. This is also made clear through the overlap of coding themes in the second phase of the research work: there were markedly more reflective statements that coded in more than one thematic category in the second phase of the research work. These themes have not been combined in this analysis in order to preserve this distinction in the data. Additionally, students had developed a familiarity with the class dynamic, with their section peers, and with their role in the larger university community before beginning phase two of the study. The steep learning curve present in all first-year student experiences may have been a factor in the type of work generated by students for analysis. Instructors interested in considering the role of design thinking within the development of critical thinking and reflective practice in first-year programs may consider reordering the introduction of learning strategies or running two different classes in parallel in order to assuage this effect.

Finally, many student participants indicated in their reflective statements and during the debriefing sessions that they were not comfortable with group work and group discussion. This is a critical issue for many undergraduate students and a notable one for first-year students in general. This discomfort with group work may have caused some contributions to go unheard during class time or even have caused some students to silence themselves during the creation of questions in phase one and phase two of the study. In the future, this research could be replicated in a grade-free context in order to better understand whether it is the group work or the assessment structure that has caused this discomfort. It is important to note that though students reflected on their discomfort with group work, none of the participants indicated that this discomfort extended to non-participation in the class learning.

Conclusion

This research demonstrates that design thinking practices, when integrated into a playful, peer directed, project-oriented, and passion-fueled learning engagement, may improve creative and critical thought and may enable students to achieve question-focused and divergent thinking-focused learning outcomes more easily. The core of all student learning is in asking strong, divergent, and resonant questions—this study demonstrates that the inclusion of design thinking practices in an undergraduate learning community may foster the skills required to do this critical work.

This research helps outline why and how design thinking can be an effective learning strategy and how it can be reimagined as a formative research methodology to be used in any learning engagement. The data generated in collaboration with students as part of this study indicates that the skills developed through the use of design thinking practices can be transferred to other learning engagements and that students find this form of learning engaging and well aligned with a growth mentality. By demonstrating the ways in which design thinking practices can support divergent thinking, creative practice, critical thought, and student learning this study makes it clear that design thinking is not just for designers anymore.

Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

References

Beckman, S. L., & Barry, M. (2007). Innovation as a learning process: Embedded design thinking. *California Management Review*, *50*, 25–56.

Borneman, J., & Hammoudi, A. (2009). The fieldwork encounter, experience, and the making of truth: An introduction. In J. Borneman & A. Hammoudi (eds.), *Being there: The fieldwork encounter and the making of truth* (pp. 1–24)*.* University of California Press.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101.

Briggs, S. (2014). 30 ways to inspire divergent thinking. [Blog posting] https://www.opencolleges.edu.au/informed/features/divergent-thinking/

Brown, T. (2008, June). Design thinking. *Harvard Business Review*, 84–92.

Charosky, G., Hassi, L., Leveratto, L., Papageorgiou, K., Ramos, J., & Bragos, R. (2018, October). Education for innovation: Engineering, management and design multidisciplinary teams of students tackling complex societal problems through Design Thinking. In *4th International Conference on Higher Education Advances (HEAD'18)* (pp. 1081–1087). Editorial Universitat Politècnica de València.

Cross, N. (2006). *Designerly ways of knowing.* Springer.

Cross, N. (2011). *Design thinking: Understanding how designers think and work*. Berg.

Dorland, AM. (2018). *Doing design thinking: An ethnography of the digital graphic design studio* [Doctoral dissertation, University of Calgary]. The Vault: Electronic Theses and Dissertations. http://dx.doi.org/10.11575/PRISM/31949

Dorst, K., & Cross, N. (2001). Creativity in the design process: Co-evolution of problem-solution. *Design Studies*, *22*, 425–437.

Dweck, C. (2008). *Mindset: The new psychology of success.* Random House.

Earley, M. A. (2014). A synthesis of the literature on research methods education. *Teaching in Higher Education*, *19*(3), 242–253.

Felten, P., Bagg, J., Bumbry, M., Hill, J., Hornsby, K., Pratt, M., & Weller, S. (2013). A call for expanding inclusive student engagement in SoTL. *Teaching & Learning Inquiry: The ISSOTL Journal*, *1*(2). 63–74.

Glen, R., Suciu, C., Baughn, C. C., & Anson, R. (2015). Teaching design thinking in business schools. *The International Journal of Management Education*, *13*(2), 182–192.

Goldschmidt, G. (2016). Linkographic evidence for concurrent divergent and convergent thinking in creative design. *Creativity Research Journal*, *28*(2), 115–22.

Guilford, J. P. (1967). *The nature of human intelligence.* McGraw-Hill.

Hassi, L., & Laasko, M. (2011). Conceptions of design thinking in the management discourse. *Proceedings of the 9th European Academy of Design Conference*.

Helfand, J. (2016). *Design: The invention of desire.* Yale University Press.

Henriksen, D., Richardson, C., & Mehta, R. (2017). Design thinking: A creative approach to educational problems of practice. *Thinking skills and creativity*, *26*, 140–153.

Hsieh, H., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277–1288.

Huber, M. T., & Hutchings, P. (2005). *The advancement of learning: Building the teaching commons*. Jossey-Bass.

Hutchings, P. (2000). *Opening lines: Approaches to the Scholarship of Teaching and Learning.* Carnegie Foundation for the Advancement of Teaching.

IDEOU. (2019). *IDEOU. Solve anything creatively.* [Web page]. Retrieved from https://www.ideou.com/

Iverson, B. (2018). *The importance of learning to ask the right questions.* https://news.utexas.edu/2018/03/05/the-importance-of-learning-to-ask-the-right-questions/

Kelly, T., & Kelly, D. (2013). *Creative confidence: Unleashing the creative potential within us all.* Crown Publishing.

Kuh, G. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter*. Association of American Colleges and Universities.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge University Press.

Matthews, J., & Wrigley, C. (2017). Design and design thinking in business and management higher education. *Journal of Learning Design*, *10*, 41–54.

Minigan, A., & Beer, J. (2017). Inquiring minds: Using the question formulation technique to activate student curiosity. *The New England Journal of History*, *74*(1). 114–136.

Rashdan, W. (2017). Impact of design thinking on conceptual design in interior design studio courses. *PEOPLE: International Journal of Social Sciences*, *3*, 85–99.

Resnick, M. (2017). *Lifelong kindergarten. Cultivating creativity through projects, passion, peers, and play*. MIT Press.

Roberts, J. P., Fisher, T. R., Trowbridge, M. J., & Bent, C. (2016). A design thinking framework for healthcare management and innovation. *Healthcare (Amsterdam, Netherlands)*, *4*(1), 11–14. https://doi.org/10.1016/j.hjdsi.2015.12.002

Rothstein, D., Santana, L., & Minigan, A. (2015). Making questions flow. *Educational Leadership, 73*(1). 70–75.

Samberg, M. J. (2018). *Problem solving in the digital age: Bringing design and computational thinking to the K-12 classroom* [Doctoral dissertation, East Carolina University]. The ScholarShip: East Carolina University's Institutional Repository. https://thescholarship.ecu.edu/handle/10342/6714

Schön, D. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.

Suchman, L. (2011). Anthropological relocations and the limits of design. *Annual Review of Anthropology*, *40*(1), 1–18.

Tschimmel, K., & Santos, J. (2018). How designers can contribute to education. *Advances in Intelligent Systems and Computing*.

Williams, A., Verwoord, R., Beery, T., Dalton, H., McKinnon, J., Strickland, K., Pace., J., & Poole, G. (2013). The power of social networks: A model for weaving the scholarship of teaching and learning into institutional culture. *Teaching & Learning Inquiry: The ISSOTL Journal*, 1(2). 49–62.

Winn, S. (1995). Learning by doing: Teaching research methods through student participation in a commissioned research project. *Studies in Higher Education*, *20*(2), 203–214.

Wrigley, C., Mosely, G., & Tomitsch, M. (2018). Design thinking education: A comparison of massive open online courses. *She Ji: The Journal of Design, Economics, and Innovation*, *4*(3), 275–292.

Wrigley, C., Nusem, E., & Straker, K. (2020). Implementing design thinking: Understanding organizational conditions. *California Management Review*, *62*(2), 125–143.

World Economic Forum. (2018). *The future of jobs report.* Centre for World Economy and Society, World Economic Forum.