Teachers as Designers:

Epistemic Diversity and Sensemaking Amidst Indeterminacy

by

Melissa Christine Warr

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Graduate Supervisory Committee:

Punya Mishra, Chair
Katherine Anderson
Michelle Jordan

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ABSTRACT

In this three-article dissertation, I explore what it means for teachers to be designers in three different ways. Each article can stand on its own, but taken together, they paint a rich and nuanced picture of the relationship between teachers and design.

The first article is an analysis of a decade of literature on teachers and design seeking to answer the question, “What does it mean for a teacher to be described as a designer, or for the act of teaching to be considered an act of design?” The analysis combined an interpretive content analysis of central terms and constructs with a network analysis of co-authorship and citation practices. The results highlighted 10 strands of literature around teachers and design, each describing a different perspective on what, how, when, and why teachers design.

The second article focuses on a design-based professional development (PD) program I conducted with four teachers in a rural junior high school. The program was designed to support teachers in approaching problems of practice in designerly ways, including exploring problems using various epistemic perspectives. Using an embedded case analysis approach, I found that although each teacher interpreted the program differently, all described outcomes related to coming to know in new ways, developing a deeper understanding of students, and being impacted at a personal level. These outcomes could be interpreted as a type of sensemaking, where teachers came to re-interpret the past and present in ways that allowed them to shape the future. Sensemaking was supported through epistemic diversity and the acts of framing common in design practice.

The third article is a scholarly essay arguing that the PD program and its implementation suggest design is not only about creating things but is also about seeing and addressing the indeterminacy inherent in complex situations of practice. Designers interact with this indeterminacy through imposing a frame on the situation and interpreting the results. When teachers are designers, they are empowered to integrate their personal and professional selves with the design situation, all while maintaining a form of skeptical optimism within complex and shifting contexts.

This dissertation is dedicated to my parents, for their unconditional love and support. It is because of you that I have the courage to embark on new adventures.

And to Karyn, whose words and deeds convinced me that I was worth saving.

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Identifying the origin of any idea is a useless endeavor. As I reflect on the development of the ideas presented in this dissertation, I am taken on a journey spread across time, people, and space. While it is impossible to acknowledge all who impacted this work, I would be remiss if I did not mention those central to it.

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CHAPTER 1

INTRODUCTION

Many scholars have highlighted the work teachers do as design work, but what does this mean about who teachers are? In this manuscript, I present three articles on teachers and design, moving from a literature analysis to a case study and finally to a scholarly essay.

Before providing a brief outline of each article, I believe it is important to contextualize these three articles and provide a frame for understanding how this line of work came to be. On September 27, 2019, I wrote a blog post on the website talkingaboutdesign.com explaining what *is* and what *is not* design. The post was a response to a peer's post on the same topic. It was an attempt to complicate the idea of design as designers are all about complicating things (Redström, 2017).

In the post, I described design as "creating a space within a particular (and complex) context and operating within that space" (Warr, 2019, para. 8). Design is about working in the particular, and anchoring work in the particular is what enables designers to address complexity. Then I wrote this:

> I can design a professional development program for a particular group of teachers in a particular place and at a particular time, but I have to recognize *that these particularities will change even while I am designing* [emphasis added]. I move forward by acting and reflecting, remaining flexible and ambivalent. I develop a problem and solution, making each fit each other in this particular, complex context. (para. 12)

These words were almost prophetic. At the time, I had created a curriculum for an eight-workshop design exploration for teacher professional development. I was engaged in establishing a relationship with a school where I would pilot the program. Little did I know that after three workshops, the particularities would indeed change as the COVID-19 pandemic led to school closures and stay-at-home orders.

Adapting to the new context was not easy. A core principle in my research was to have teachers design for problems they were facing in their own classrooms, and the professional

development program was based on teachers experimenting in their classrooms and then reflecting on the results. With schools moving to distance learning, particularly in this rural school district with limited internet access in the community, teachers had few opportunities to experiment in their practice. Moreover, teachers were stressed and overwhelmed; they didn't need me adding more to their plates. Rather, they needed a space to reflect and defuse. My dissertation research was at best a distraction and at worst, meaningless. I was keenly aware that pushing them to do something simply for my research would be borderline unethical. So, I pivoted to do something that I hoped would be valuable to them.

In the weeks after the school closed in March 2020, the teachers and I spent time discussing the challenges of being a teacher in a rural school during the COVID-19 pandemic. We focused on the disconnect we felt as we adjusted to our new "socially distant" way of being. Eventually, we transferred our personal experiences to the challenges students might be having. The school principal shared concerns about the mental health of the community, and we considered what we might do to support students during this challenging time. We homed in on the idea of relatedness, that developing connections between students, teachers, and content can increase learner engagement. It seemed that during the pandemic, relatedness might be both incredibly important and difficult to support. In May and June, we investigated research literature that described the relationship between relatedness and learning engagement, explored our personal experiences with relatedness, and interviewed students about what school during a pandemic was like for them. In July, we attempted to take what we had learned and incorporate it into various activities that we would first complete together, then revise for implementation with students once school started again.

Through it all, I wondered if what we were doing was really design and whether this work was beneficial to the teachers. And, of course, in the back of my mind, was whether any of this would be relevant to my dissertation research. The teachers were not actually implementing anything new in their classrooms. It was not the type of design highlighted by the literature on teachers and design—literature that described how teachers developed professional knowledge

as they created professional products like lesson plans and curriculum. Yet, the teachers insisted that what we were doing was helpful to them.

At the conclusion of the program, I interviewed each teacher about their experiences in the workshops. I started with this question: “If another teacher asked you what we were doing, what would you say?” To my surprise, each teacher had a different way of describing what we were doing together. We were helping students, collaborating, looking at things differently, or engaging in creative design. Yet, for each teacher, what they described was helpful to them and resulted in personally significant outcomes.

As I analyzed the data and puzzled over these differences, I came to see that what was happening in these workshops was not about designing a lesson plan, a classroom procedure, or school culture. It was about how each of us was making sense of the particular situation—for the teachers, being a teacher in a rural Title-1 school during a pandemic—as well as the larger context (managing life during a pandemic). Making sense looked different for each of us, as we each brought our own personal experiences, beliefs, and identities to the situation. Yet, through exploring a common idea—relatedness—we were able to help each other see in new ways and find productive paths for moving forward.

Through this experience, I learned that design is not just about the external products or processes designers create. It is just as much about an individual sensemaking process, where designers build their own understandings of a situation through trying out different interpretations and listening to the results. The outside observer sees a designer creating things. However, just, if not more, significant is the internal sensemaking process that accompanies design. I came to realize that the power of design comes through seeing the situation, and the broader context, in ways that lead to action. And this, what happens on the inside, can be powerful.

This dissertation consists of three journal articles that, in a way, illustrate this shift from a focus on the external products of design to the internal sensemaking that can occur through design. The first article, “Integrating the Discourse on Teachers and Design: An Analysis of Ten Years of Scholarship,” explores the current literature on teachers and design. This literature

focuses primarily on the external life of teachers as designers, such as what they design, whom they design with, and when they design. It provides a brief glimpse into what might happen on the inside of a designer, as the literature connects through common themes of constructivism and the contextual development of professional knowledge. However, the focus remains on professional design work and rarely considers the personal.

The second article, "'Bringing in the Self': Teachers, Design, and Sensemaking," begins a shift from a focus on what teachers design to what it is like for teachers to design. In this article, I constructed a case study to investigate the outcomes of the program as well as what activities supported those outcomes. I found sensemaking to be a central theme in the data: the teachers and I worked together to see things in ways that would support future action. This was accomplished through epistemic diversity (seeing a situation in many different ways) combined with framing, the act of selecting a way to interpret the situation.

It was in writing the third article, "'Seeing Things Differently': Teachers, Design, and Indeterminacy,'" that I began to understand how the type of design the teachers and I engaged in connected to the personal outcomes we each experienced. I considered what was different between the way I was encouraging teachers to work in these workshops and how they normally work. By looking carefully at what was difficult as well as what was significant to the teachers, and integrating my understandings of design literature, I came to see that what is unique about design is that it operates in indeterminacy. Seeing this indeterminacy did not come naturally for the teachers, but as we continued to collaborate, there was evidence that they were beginning to see their practice in a new way. It was the indeterminacy that allowed for personally significant outcomes; design is about interpreting situations, and those interpretations are influenced by who the designer is and the context around them. Designers reify their interpretations in the "thing" they design, but the core of being a designer is not the external result, but the internal process of interpreting amidst indeterminacy.

Chapters 2, 3, and 4 each present one of the articles described above. After presenting these articles, I will provide final thoughts in chapter 5.

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CHAPTER 2

INTEGRATING THE DISCOURSE ON TEACHERS AND DESIGN: AN ANALYSIS OF TEN YEARS OF SCHOLARSHIP

Melissa Warr

Punya Mishra

Arizona State University

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Abstract

This article presents a content and network analysis of a decade (2007–2017) of highly-cited literature on teachers and design. Constructs and definitions were compared in an interpretive content analysis, resulting in 10 strands, each a cluster of literature that frames teaching and design in a particular way. A citation network analysis provided insight into how the strands are conceptually related. Further analysis highlighted how each strand described what, when, and how teachers design, and the value of considering teachers as designers. The results suggest that teaching not only includes design activities, but could be considered a design profession. This perspective has implications for teacher education, specifically the development of professional knowledge.

Keywords: design, participatory design, learning design, curriculum design, social network analysis

Introduction

What does it mean for a teacher to be described as a designer, or for the act of teaching to be considered an act of design? Scholars in several fields of educational research describe teachers as designers of learning and instruction (e.g., Carlgren, 1999; Koehler & Mishra, 2005; Könings et al., 2005; Norton & Hathaway, 2015). The discourse on teachers and design is broad and spreads across disciplinary fields, including learning science (Penuel & Gallagher, 2009), instructional design (Moallem, 1998), mathematics education (Brown, 2011), and teacher education (Jordan, 2016). It includes various applications of design to teacher's work. For example, teachers design curriculum individually or in teams (Penuel & Gallagher, 2009; Voogt et al., 2015), participate in designing school buildings or physical classroom spaces (Woolner, 2010), and design alongside researchers (Severance et al., 2016). Teachers' ongoing adaptations in daily instruction have also been considered a design activity (Hauge, 2014).

The lack of clarity in scholarship around teaching and design has been noted by others. It was recently addressed by Persico et al. (2018) in an editorial introducing a special issue in the *British Journal of Educational Technology* on "Teachers as Designers of TEL (Technology-Enhanced Learning) Interventions." The authors pointed to blurred definitions and multiple interpretations of the topic to the extent that only 24% (35 of 146) of submissions for the special issue met the scope of the issue proposal. They also observed that most of the papers followed similar lines of research, making it "difficult to see wholly new lines of research" (p. 977). In this article, we provide a possible response to Persico et al. by seeking to clarify both how strands of scholarship define and interpret the idea of teaching as design and the nature of the relationships among strands. Through our analysis of a decade of literature on teachers and design, we offer a conceptual map of the domain and explore implications for teacher education and practice.

There have been a few attempts to categorize the literature on teachers and design, though each has been limited in some way. Mor and Craft (2012) discussed research perspectives on learning design but did not include other literature on teachers and design. Similarly, Voogt et al. (2011) presented an analysis of nine studies on teachers as designers, but

their scope was limited to teachers working in teams to develop curricular artifacts. Finally, Kali et al. (2015) provided a framework for understanding research on teachers as designers but, like the 2018 BJET special issue, restricted their description to design for technology-enhanced learning.

As observed by Persico et al. (2018), the literature about teachers and design uses many terms or constructs to explore the relationship between teaching and design. For example, authors use phrases such as “learning design,” “participatory design,” “curriculum design,” and “design thinking” to describe how and what teachers design. Many of the phrases are similar, such as “learning design,” “design for learning,” and “learning by design.” Some authors use these terms interchangeably, while others use the same term but seem to define it differently. Even the word “design” itself is applied inconsistently (Holmberg, 2014).

Each of these approaches emphasizes certain aspects of teachers as designers while under-emphasizing others. We believe that if the idea of “teachers as designers” is to hold meaning, we need to develop a more nuanced picture, one that accounts for the wide diversity of work. By considering the ways teachers are framed as designers, we can better understand teachers and design—what it is and what it could be, and how it might enable new possibilities for teacher education and practice.

In this paper, we seek to construct a broad representation of the current literature on teachers and design by identifying and comparing various strands of literature. We use the term *strand* to describe thematically connected clusters of research that use constructs relating to teaching and design in similar ways. Because academic writing is the primary way scholars construct meaning and build on one another’s work (Hyland, 2014), authors who draw upon each other’s ideas through co-authorship and citation practices often can be categorized as part of the same strand—i.e., they co-construct similar ideas.

The structure of the paper is as follows. First, we provide an overview of design and teaching, including why researchers are increasingly describing teachers as designers. Second, we describe two analysis methods (interpretive content analysis and network analysis) that we will apply to the literature. We also present a tailored process of selecting literature and provide a

summary of our analysis methods. Finally, we offer the results of our analysis: we (a) identify various strands of research; (b) describe the key constructs belonging to each; (c) demonstrate how the strands are connected conceptually; and (d) consider how each strand describes what is designed, who engages in the design work, when design occurs, and the benefits of viewing teachers as designers. The analysis supports the idea of teaching as a *design profession,* and we discuss implications for teachers' professional knowledge and teacher education.

Why Design?

We start by exploring what design is and why it is important. Several lines of research explore how teachers create lessons or curriculum for their classrooms. For example, in lesson (or learning) study, teachers develop professional knowledge through collaboratively designing and evaluating lessons (Fai & Runesson, 2019; Vrikki et al., 2017; Wood, 2020). Additionally, some have used the term "teachers as developers" to describe how and why teachers develop and interpret curricular materials (Bouckaert, 2019; Shawer, 2010). Although these are valuable strands of work on teaching education and practice, we focused our analysis on the term *design* for two primary reasons. First, design is a general term that can reflect a complex concept that goes beyond isolated professional learning or development of educational materials. Goodyear and Dimitriadis (2013) described that design "should have value, and be understood, within the regular on-going flow of educational activities" (p. 3), not as something that only occurs in some situations. Second, design is a word that is being increasingly used in education, and it is important that we clarify how and why we use it (see Lahey, 2017).

A Brief Overview of Design and Teaching

Scholars offer several definitions of design. Simon (1969) described design as a process of rational decision making intended to change something from how it is to how it "ought to be" (p. 4). According to Simon, "Everyone designs who devises courses of action aimed at changing existing situations into preferred ones" (p. 111). A wide range of professions fit Simon's definition of designers: doctors design remedies, entrepreneurs design sales plans, and philanthropists design social programs.

Donald Schön (1983; 1992) extended Simon's ideas to develop a framework for the *process* of design, describing design as an epistemology based on the union of thought and action. Building on Dewey's Theory of Inquiry, Schön (1992) described design as being social and transactional, combining mental reasoning and action, and leading to the development of knowledge from common sense. Schön described the core of design as "reflection-in-action," a process where designers adjust practice based on feedback from the environment. Reflection-in-action might include an architect's revisions and extensions on a blueprint, a basketball player's dribble around a defender, or a teacher's adjustments to a lesson in response to a student's comment. Reflection is not usually verbal or metacognitive, rather, it is a tacit action deeply embedded in practice.

Cross (2006) extended Schön's epistemological frame by arguing that design is a specific way of thinking and acting. He suggested that design had "its own distinct things to know, ways of knowing them, and ways of finding out about them" (p. 1). Cross argued for designerly ways of being which included striving to understand others, generating and testing ideas, and adjusting practice based on the results. He argued that designers approached difficult, complex problems in tenacious, dynamic ways by drawing on both personal knowledge and practical experience (Jobst & Meinel, 2014).

Hauge (2014) described Simon's and Schön's perspectives as complementary pieces of design in education. Hauge associated pre-implementation design—such as teachers developing lesson plans or the physical classroom environment—with Simon's work, while interactions during instruction reflected Schön's ideas. Hauge's perspective highlights design itself as reflexive and emergent; it is the integration of knowing and doing.

Research centered on teachers and design has expanded significantly over the past few decades (Goodyear & Dimitriadis, 2013). Possible reasons for the attention given to teaching and design include the wide-spread application of design to other non-traditional design fields, a push for integrating technology into the classroom, the need and expanded ability for sharing ideas

among practitioners, and the adoption of 21st century learning pedagogies. We expand on each of these reasons to contextualize our discussion.

First, recent years have seen a rise in the application of design principles to a range of fields including business, social activism, and government (Kimbell, 2011), perhaps because of design's ability to address complex or "wicked problems" (Buchanan, 1992). Design has expanded from a focus on epistemology to a way that practitioners, in cooperation with other stakeholders, can address more systemic problems (Jordan et al., 2014). The expansion broadened design use and research. Buchanan's description of design for wicked problems makes it particularly relevant to education, as many issues in education tend to be broad and intransigent.

Other applications of design to education stem from research on classroom technology integration and implementation (Kali et al., 2015; Koehler, Mishra & Yahya, 2007). Successfully integrating technology into the classroom requires a shift in pedagogy (Fullan, 2013; Hokanson & Hooper, 2004), and a shift in pedagogy means creating new learning designs (Hauge, 2014). Technology integration also raises questions concerning innovation implementation (Brown, 2008; Penuel, et al., 2011). For example, who should design educational innovations? Should teachers implement the innovations in a consistent manner, or should they adapt to their local context? Whether or not teachers design a new curriculum or technology, they become designers of implementation. Scholars have found focusing on teachers as designers facilitates new perspectives on technology and program implementation (Davis et al., 2011).

Related to issues of implementation, researchers have also considered how learning designs, such as designs for specific teaching methods, can be externalized and shared across teachers. Other design fields, such as architecture and user-interface design, provide representations of designs that externalize the ideas of practitioners, enabling reflection, sharing, and adaptation (Dalsgaard, 2014; Dorst, 2010). However, externalizing teachers' design knowledge, including the practices and implementations they create and the resulting outcomes, can be challenging (Brown, 2008; Conole, 2013). Researchers described learning objects as one

method of representing designs. In particular, open educational resources (OER's) provide an open format for reusing and repurposing designs (Wiley, 2002). Teachers can create and adapt resources for their classrooms, and the OER structure enables and encourages open sharing of these resources.

A final reason for the spread of work on teachers and design involves the push for 21st century learning pedagogy (Koh et al., 2015). The Partnership for 21st Century Learning (2015) presented an outline of what students need to be successful in today's work force. Identified core competencies include key subject matter, learning and innovation skills, informational technology skills, and life and career skills. Developing these competencies requires new pedagogical methods, and scholars propose teacher design work as an approach to developing and implementing 21st century learning (e.g., Beetham & Sharpe, 2013; Koh et al., 2015; Razzouk & Shute, 2012).

The reasons for connecting teaching and design can be quite diverse. In fact, these differing approaches (though connected by the same key words: teachers/teaching, designers/design) can have different meanings and avenues for sharing ideas. This means that perspectives can grow independently of each other, developing their own coteries of citations often siloed and isolated from each other. This can prevent cross-pollination and the development of new insights.

This paper emerges from the need to better understand the diverse areas of research on teachers and design. This work hopes to systematically identify both strands of research and the relationships among strands. Our concern is that if we fail to understand the breadth of research on teachers and design, we risk missing important insights and diminish the impact of separate strands of research.

Research Questions

In this paper, we seek to begin the work of connecting the literature by identifying the current strands of scholarship around the idea of teachers as designers. By "strand," we mean a cluster (or connected set) of scholarly work that draws on similar constructs and perspectives. For

example, authors within a strand present a common perspective on *what* and *when* teachers design. One strand might see teachers as those who design through in-the-moment lesson adaptations. A different strand might describe teachers designing learning opportunities before students even arrive in the classroom.

In this paper, we describe how these strands are defined and illustrate the relationships among them. Specifically, we attempt to answer:

1. What are the strands of scholarship that describe teachers as designers?
2. How are the strands connected conceptually?
3. How does each strand apply design to teachers' work?

Methodology

We applied an academic discourse perspective to address our research questions. We draw upon Hyland's (2011) definition of discourse as "the community's knowledge and activities" (p. 19). Scholars can learn about a community's discourse through its use of language—the epistemologies, rhetorical structure, types of claims, and central topics. An academic discourse perspective considers how academic discourse—particularly the scholarly activity of academic writing—builds meaning and enables connections across research fields (Hyland, 2004). It highlights how academic knowledge is constructed as researchers argue for certain perspectives, build on each other's work, and interact with ideas.

We draw upon four tenants of Hyland's (2004; 2011; 2014) work. First, discourse reflects the social interaction in a discipline (Hyland, 2004). The primary mode of scholars' interactions consists of writing, whether through journal articles, conferences proceedings, or books. Second, discourse mutually constitutes discipline and builds meaning. Hyland (2004) explained, "Discourse is socially constitutive rather than simply socially shaped; writing it not just another aspect of what goes on in the disciplines, it is seen as producing them" (p. 3). Third, discourse is a site for conflict and facilitates resolution of that conflict (Hyland, 2011). Authors present ideas that either build on others' ideas or contradict others' positions, leading others to respond and

enabling the development and resolution of knowledge. Finally, academic discourse relies on connections across authors to build meaning in a discipline (Hyland, 2014).

We utilized two descriptive methods to better understand the content and structure of discourse on teachers and design. We applied an *interpretive content analysis* to understand the conceptual perspectives of the authors in the texts and visualized the structure of the literature through *network maps* of co-authorship and citation practices. The combination of these two approaches enabled both a conceptual and relational analysis of the discourse. We describe each below.

Content Analysis. Content analysis is a broad field of research methods at the intersection of qualitative and quantitative methods. Krippendorff (2019) described content analysis as "a research technique for making replicable and valid inferences from texts . . . to the contexts of their use" (p. 24). Content analysis assumes that language is central to human cognition, changes in words reflect changes in ideas, and use of similar terms suggest some type of association (Duriau et al., 2007). Although content analysis can take many different forms, it includes systematic steps taken to draw inferences from a text. Duriau et al. (2007) listed several advantages of content analysis, including methodological flexibility, replicability, and unobtrusive access to data. Content analysis can center on quantitatively describing texts (word count, word frequencies, etc.) or apply an interpretive lens to consider meanings of the texts (Krippendorff, 2019), but in each approach, the analyst uses elements of the text to make inferences about the context they are embedded in.

From this perspective, academic literature—including key terms and vocabulary used—provide insight into the academic community's understanding of a phenomenon. The method provides an approach to analyzing conceptual perspectives through texts. For example, we might infer that authors using similar terms in similar ways come from related conceptual perspectives. In this study, we used interpretive content analysis to identify key constructs used in the teachers and design literature, the definitions of those constructs, and the ways in which researchers have applied design to teachers' work.

Network analysis. Although content analysis supports the development of a general understanding of perspectives on teachers and design, network analysis offered additional tools for understanding and visualizing the relationships across perspectives. Academic communities build knowledge through co-authorship and citation practices, and analyzing the relationship amongst authors and their use of citations can provide insight into the structure of a discipline (Dawson et al., 2014; Tight, 2008). One method of understanding connections among people or objects is network analysis (Tight, 2008) which consists of analyzing nodes, the people or objects, and edges, the connections between nodes (Dawson et al., 2014). In co-authorship network analysis, each author becomes a node, and edges represent each time an author publishes with another author. In citation network analysis, each publication and each of the authors the publication cites could be considered nodes, with edges connecting the publication with the authors it cites (Tight, 2008). A visual representation of the data is created by applying an algorithm that minimizes the average physical distance of the edges. Network analysis maps can highlight discourse structures, including the strength of connections and clusters of work (Desmedt & Valcke, 2004).

Network analysis has been applied to a variety of educational research and academic discourse investigations. In education, for example, researchers used social network analysis to understand relationships in online learning forums and message boards (Russo & Koesten, 2005) as well as social relationships in classrooms (Grunspan et al., 2014). Dawson et al. (2014) performed an author network and citation analysis to understand disciplinary structures of learning analytics publications. Researchers have also applied co-authorship analysis to understand top authors in higher education journals and to investigate the impact and structure of co-authorship practices in management and organizational studies (Tight, 2008).

One of the limitations of co-authorship and citation analysis is that it can generate random patterns (Waltman et al., 2013). Self-citation practices as well as cronyism may affect analysis. In other words, citations may occur from social connections or self-promotion rather than the structure of the discourse (Tight, 2008). However, Tight (2008) emphasized that

although citation analysis does not provide an exact mapping of a discipline, it does provide indications of disciplinary structure and can be illustrative when combined with other analysis methods. We addressed these weaknesses in two ways: first, by removing self-citations when constructing the citation network map and, second, by triangulating findings with other analytic methods. Specifically, we used network analysis to visualize connections identified through interpretive content analysis.

Method

In this section, we provide a summary of the article selection process and analysis procedures. Interested readers can find a more complete description of our methods in Appendix A and B.

We began by conducting "scoping searches" (see Booth, et al., 2016) to identify databases and search terms that would best retrieve relevant literature. We identified four articles (Jordan, 2016; Kali et al., 2015; Könings et al., 2014; Razzouk & Shute, 2012) similar to the types of literature we hoped to retrieve and checked search queries for the inclusion of these articles. Our scoping search revealed that certain databases (such as ERIC, Google Scholar, and CrossRef) either did not provide satisfactory results or provided limited information. Our final lists of databases included *Web of Science, SCOPUS*, and *Microsoft Academic*.

Before beginning the full literature search, we defined three criteria for inclusion in this study. First, the publication must discuss design approaches or techniques to solving educational problems (designing lessons, programs, school buildings, technology use, policies, etc.). Second, the research should focus on K-12 education and discuss design as it applies to teachers. For instance, our method excluded work focused on design as a curriculum area (teaching students design techniques), researcher-focused work in design-based research, and instructional design literature centered on the work of professional designers who are not K-12 teachers. Finally, the publication must include a complete definition or description of design or a design-related construct (designer, design thinking, teacher design team, etc.). This criterion differentiated literature that mentioned design in passing or did not critically investigate what is meant by design

from literature explicitly focused on design. It was necessary to support an interpretive content analysis of constructs and definitions.

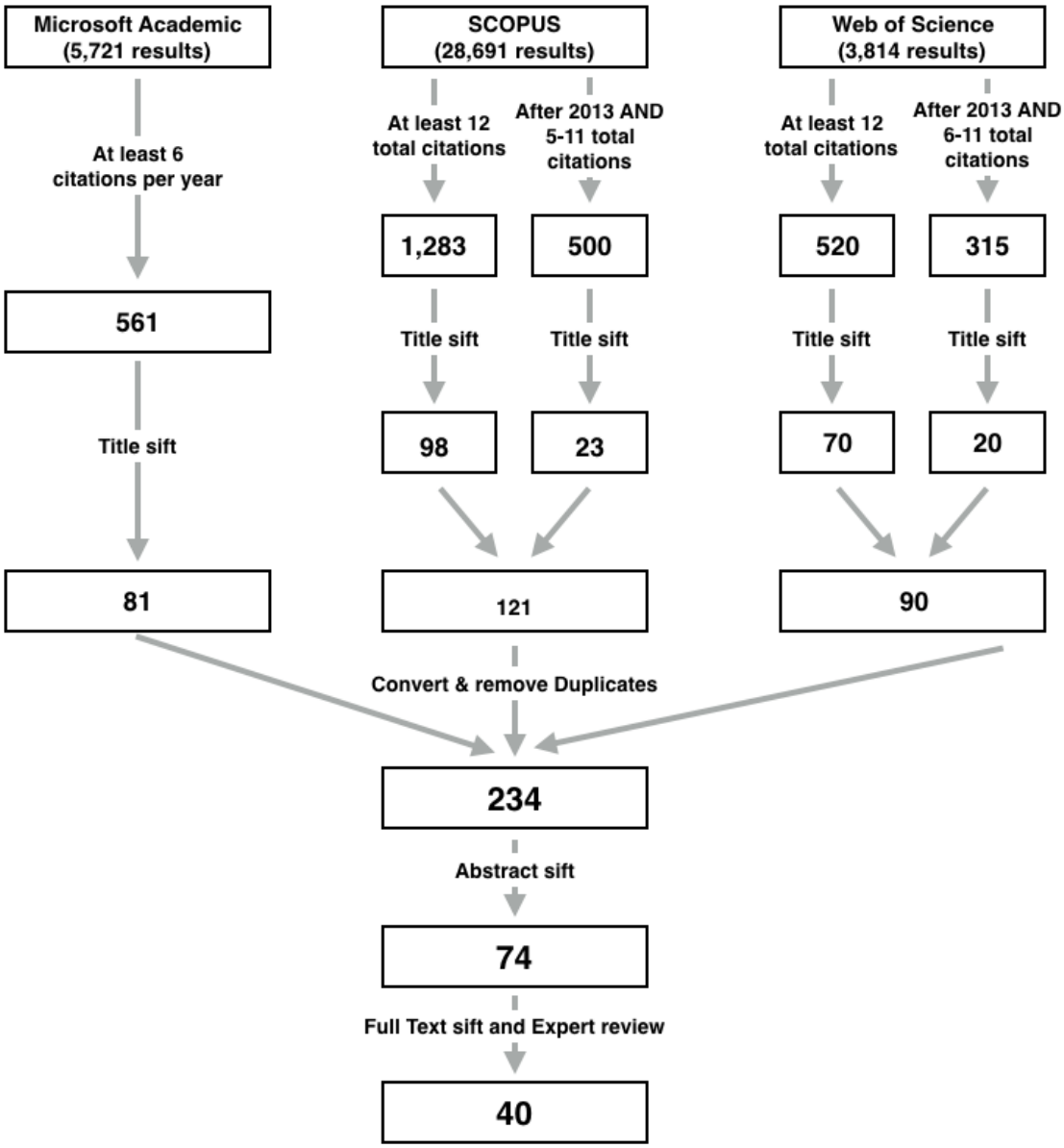
Since each of the three databases selected was structured differently, the search queries varied slightly. Because of the prevalence of the word “design” in the literature (including phrases such as “research design”), we generally limited the initial search to publication titles. Searching only words in titles limits results and can affect the comprehensiveness of the search. However, most authors craft titles to closely reflect the reported research, forming a functional summary of an article (Sahragard & Meihami, 2016). Thus, searching for sources with the word “design” in the title can effectively identify most of the core literature focused specifically on design. Search terms included “design” and its derivatives (using a wild-card symbol where available, or including “designer,” “designers,” “designerly,” and “designs”). Where possible, findings were filtered for education-specific publications. In databases without education-specific filters, the words “teacher,” “school,” and “education” were added as search terms (the title, abstract, or keywords included teacher, school, education, and/or variants).

The search terms resulted in a greater number of publications than could be reviewed. However, because we were attempting to identify a large range of literature on teachers and design, it was important to keep the search broad. To manage the scope of the analysis, we focused on the top cited articles from 2007–2017 because (1) we are interested in the overall structure of the *current* work in the field, and (2) the most impactful literature likely anchors that structure. We used citation statistics as a measure of impact of scholarship. Though citation counts may not perfectly index quality or impact of publications (Tight, 2008), on average, higher citation counts do indicate a more significant impact, and it is reasonable to assume citation counts provide a general indication of significance (Dawson et al., 2014; Waltman et al., 2013). We selected citation thresholds with the goal of initially collecting approximately 100 pieces of literature with relevant titles from each database (further reviews of abstracts and full texts resulted in fewer final publications). As more recent publications have had less time to accumulate citations, we lowered the citation threshold for publications published between 2014

and 2017 (see Figure 1). Newer publications (those published 2018–2019) were not included in the initial analysis because of the delay between publication and accumulation of citations. After the initial search of each database, we systematically eliminated literature that did not meet our inclusion criteria through reviewing publication titles, then abstracts, and finally the full texts. As a final informal check, we asked a disciplinary expert to review the final list and indicate any missing branches of work. Based on their expertise, they believed the list was a valid representation of the literature on teachers and design. See Figure 1 for details on the number of publications considered in each step of the process. The final corpus of literature included 40 publications on teachers and design.

Figure 1

Process for Article Selection



Note. Counts represent number of publications included in each selection stage.

Analysis

In this section, we provide a summary of the analysis process. For more details, see Appendix B.

After identifying the core literature, we used content analysis and social network analysis to answer our research questions. We began by analyzing the selected journal articles. First, we read each article for a general sense of the corpus of scholarship. Then, we returned to each piece and read it again while coding and writing thematic memos. Initial coding focused on the structural elements of the texts as well as key words and definitions. Codes included research questions; goals, outcomes, and purpose; construct definition; key term(s); problem; research method; and main idea or summary statement. We returned to these codes later in our analysis to explore how the publications applied design to teachers' work.

After completing the initial coding, we focused our content analysis on the passages coded as key terms and construct definitions. We used main terms and phrases in the articles to create more refined construct codes. For example, Boschman et al. (2014) included the phrases "design teams," "collaborative design," and "curriculum design," and we created a code for each of these phrases. We wrote the phrases and definitions on index cards and sorted the cards by similar definitions. We used the sorted cards to create categories of literature and then returned to the full texts to compare the constructs and definitions to the overall purpose and context of the publication. We wrote detailed memos, documenting each publication's application of the construct and the similarities and differences within each category.

Through this process, we identified three articles that did not seem to fit with the others (Yelland et al., 2008; Hauge, 2014; Holmberg, 2014). We searched the citations of each of these publications to better understand what ideas and concepts they might be drawing upon. Although two of the three publications (Hauge, 2014; Holmberg, 2014) cite authors of other publications in the corpus, the articles presented conceptually different perspectives and so were not combined with other categories.

After we identified categories based on the journal articles, we reviewed the books, book chapters, and conference papers. Most of the publications fit well into the categories identified. However, the additional literature prompted a refinement of the learning design category. We

added a new category (“pedagogical design capacity”) for two publications (Brown, 2011; Davis et al., 2011). The content analysis resulted in 10 strands of research on teachers and design.

After completing the content analysis, we used the *GEPHI* (2017) and *UCINET NetDraw* (Borgatti, 2002) software to perform a network analysis of co-authorship and citation practices. Network analysis uses connections across elements to build clusters, or connected sets, of items. The co-authorship analysis consisted of building edges between each author and each author they published with. In other words, if authors A, B, and C were co-authors, edges connecting A and B, A and C, and B and C were created. We mapped the relationships by importing the data into *GEPHI* (see results section for a more detailed explanation and graphics).

We used *UCINET NetDraw* to create maps of citation practices. First, we downloaded references for each publication from *SCOPUS* (Elsevier, 2018), except for the reference list for Woolner (2012), which was obtained directly from the author. We created a list of all scholars cited, removed duplicates, and removed any scholars with only one citation, as a single citation provides no information on relationships across publications (scholars with only one citation have no cross-publication connections that can be analyzed). The list of publications and cited scholars formed nodes, and an edge was created from each publication to each of the scholars it cited. To minimize edges irrelevant to our research questions, self-citations were removed. For example, if a publication co-authored by A, B, and C cited an article by co-authors A and D, the edge from the publication to author A was removed from the data. The resulting maps are presented in the findings section.

Trustworthiness

We controlled for bias throughout the article selection and analysis process. First, we used a systematic process to identify key literature. Following the recommendations of Booth et al. (2016), we carefully developed a research protocol before beginning the full literature search, including goals of the literature review as well as detailed inclusion and exclusion criteria. As we queried the literature, we documented details about each query. In the next section, we present the findings of this analysis.

Results

As we analyzed the literature on teachers and design, we worked back and forth across network and interpretive content analysis. To answer the first research question ("What are the strands of scholarship that describe teachers as designers?"), we used interpretive content analysis to identify and describe strands of work and constructed a co-authorship network analysis map. Next, we answered the second research question ("How are the strands theoretically connected?") by analyzing a citation network analysis map which highlighted the theoretical relationships across strands and key connecting scholars. Finally, we returned to the content analysis and analyzed each code by strand to answer research question 3 ("How does each strand apply design to teachers' work?").

Question 1: What are the strands of scholarship that describe teachers as designers?

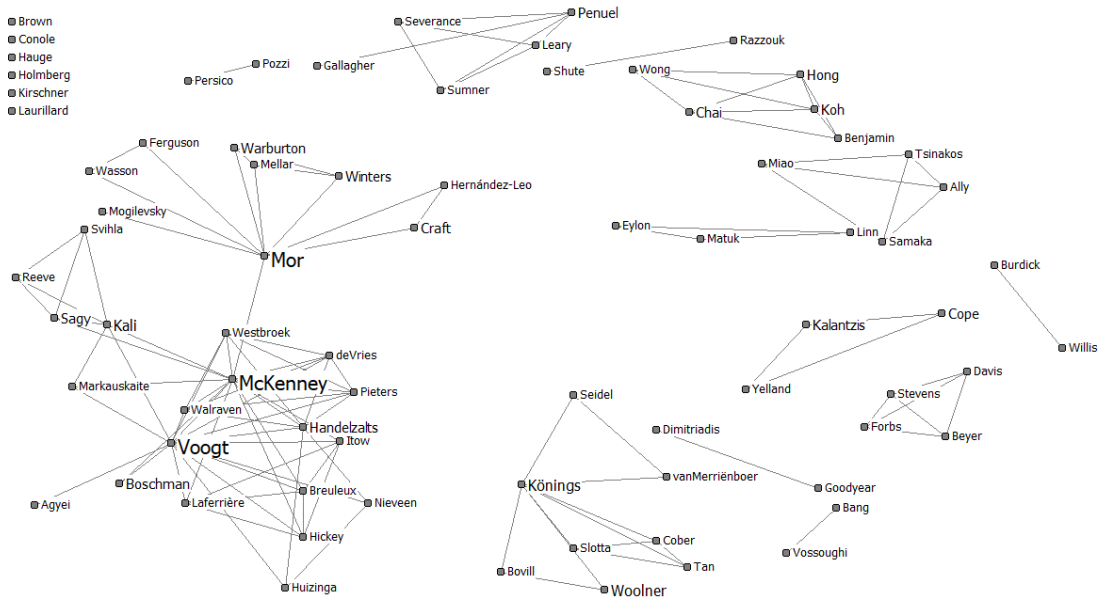
We identified the strands of teachers as designers through co-author network analysis and interpretive content analysis (see details in the Analysis section and Appendix B). The co-author network analysis map provided insight into the relationship among authors in the literature, while the content analysis provided a method for a more fine-grained analysis of the constructs themselves. Although we conducted the content analysis first, we start our presentation with the co-author analysis to better illustrate the relationship across the different types of analysis.

Figure 2 demonstrates co-authorship relationships. The map includes 77 authors connected by 420 edges. The edges resulted in 12 co-authorship clusters (authors connected through co-authorship practices) with six authors publishing independently (listed on the left side of the map). The map demonstrates the best fit after 100 iterations of an algorithm that minimizes the distance of edges connecting each node to each other node within each cluster. The clusters themselves are independent and could have been placed anywhere on the map. For example, the bottom left cluster centered around McKenney and Mor could also be placed in the top right, but the distance between authors within the cluster reflect the number of coauthored publications. The map shows a cluster in the lower left corner connecting McKenney, Voogt, Kali, and their co-authors. Another cluster to the right is centered around Könings and Woolner. The remaining

clusters are largely disconnected, with six authors (listed separately on the left side) publishing without co-authors.

Figure 2

Co-authorship Network Analysis Map



Note. This graph was created with Gephi (2017) spring embedding layout (based on similarities of geodesic distance and edge length). Although the location of each unique cluster is arbitrary, distances within clusters reflect connection strength. Size of author names reflects the number of publications by each author in the analyzed literature.

The co-author network map gives some sense of the relationships among the authors. Based on Hyland's (2014) academic discourse analysis perspective, interactions among scholars build meaning in a discipline. Thus, authors who frequently interact through co-authorship practices likely develop similar ideas and positions, what we are calling strands, and the co-author network map might provide some insight into potential strands of literature. However, the map does not reveal *what* those strands might be. Thus, a content analysis was also needed to understand the strands.

As we described in the method section, we identified the constructs, or key terms and phrases, described in each publication and compared their definitions. Through this process, we identified ten strands of literature on teachers and design. The strands are not discrete or

absolute. Some of the strands include authors using constructs with slightly different names, and authors in different strands sometimes use the same construct name. We created the strands based on how the constructs were defined and applied because our goal was to understand the conceptual perspectives on teachers and design.

We named the strands by the most used construct name or a variation of the name as needed to differentiate it from the other strands. For example, both Hauge (2014) and Goodyear and Dimitriadis (2013) used the phrase “design for learning” in their work. However, Hauge’s design for learning involved teacher adaptation of lessons during enactment, while Goodyear and Dimitriadis’s article claimed on-the-spot teacher decision making should *not* be described as design. Hauge described a symbiotic relationship between design for teaching and design for learning, emphasizing both dimensions are vital to understanding design in education. To differentiate these strands, we labeled the strand describing Hauge’s work *Design for Teaching and Learning* and Goodyear and Dimitriadis’s work *Design for Learning*.

Table 1 presents the ten strands and corresponding publications. See Appendix C for detailed descriptions of each strand. Note, although some of the strands only consist of one publication, each strand represents a unique perspective on teachers and design. Our literature review was not comprehensive (we focused on the highest-cited work), so other publications not included in this research might also fit some of the less-populated strands.

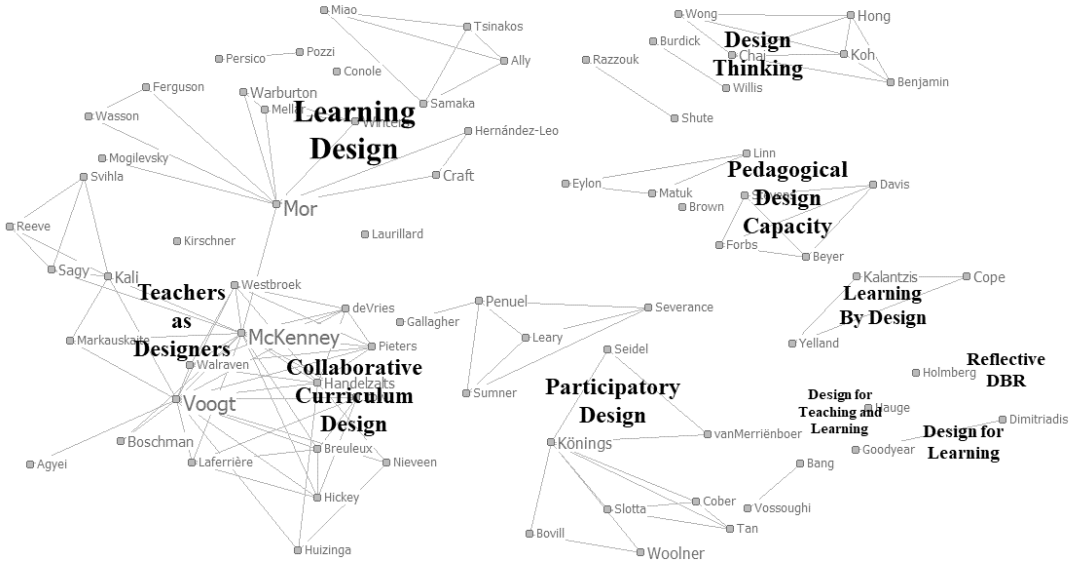
Table 1

Ten Strands of Literature on Teachers and Design

Strand	Name	Description	Publications
1	Teachers as Designers	**Teaching *is* design:** summative descriptions on teachers as designers	Kali et al., 2015; Kirschner, 2015; McKenney et al., 2015; Svihla, et al., 2015 (4)
2	Learning Design	**Patterns for learning:** creating lessons or lesson patterns and creating a common design language to enable sharing	Conole, 2013; Laurillard, 2012; McKenney & Mor, 2015; Miao et al., 2014; Mor & Craft, 2012; Mor et al. , 2013; Mor et al., 2015; Mor et al., 2014; Mor & Mogilevsky, 2013; Mor et al., 2012; Persico & Pozzi, 2015 (11)
3	Collaborative Curriculum Design	**Creating curricular reform together:** teachers work with each other, researchers, and subject-matter experts to create new curricular materials	Agyei & Voogt, 2012; Boschman et al., 2014; Boschman et al., 2015; Huizinga, Handelzalts et al., 2014; Penuel & Gallagher, 2009; Voogt et al., 2015; Voogt et al., 2011 (7)
4	Participatory Design	**Making-sense together:** engaging diverse stakeholders in projects to disrupt power relationships	Bang & Vossoughi, 2016; Cober et al., 2015; Könings et al., 2017; Könings et al., 2014; Severance et al., 2016; Woolner, 2010 (6)
5	Design Thinking	**Design epistemology**: design as a type of thinking and learning	Burdick & Willis, 2011; Koh, Chai, Benjamin, & Hong, 2015; Koh, Chai, Wong, & Hong, 2015; Razzouk & Shute, 2012 (4)
6	Pedagogical Design Capacity	**Adapting tools**: how teachers adapt tools to local context.	Brown, 2011; Davis et al., 2011; Matuk et al., 2015 (3)
7	Learning by Design	**Designing pedagogy**: teaching for multiple knowledge processes	Cope & Kalantzis, 2015; Yelland et al., 2008 (2)
8	Reflective DBR	**Process research**: Researching the process of teachers developing an artifact	Holmberg, 2014 (1)
9	Design for Teaching and Learning	**Facilitating learning**: designing situations for learning and adjusting in context	Hauge, 2014 (1)
10	Design for Learning	**Settings for learning**: Designing the teacher role, objects, and activities to enable learning	Goodyear & Dimitriadis, 2013 (1)

Figure 3

Co-Author Network Map with Strand Name Overlap



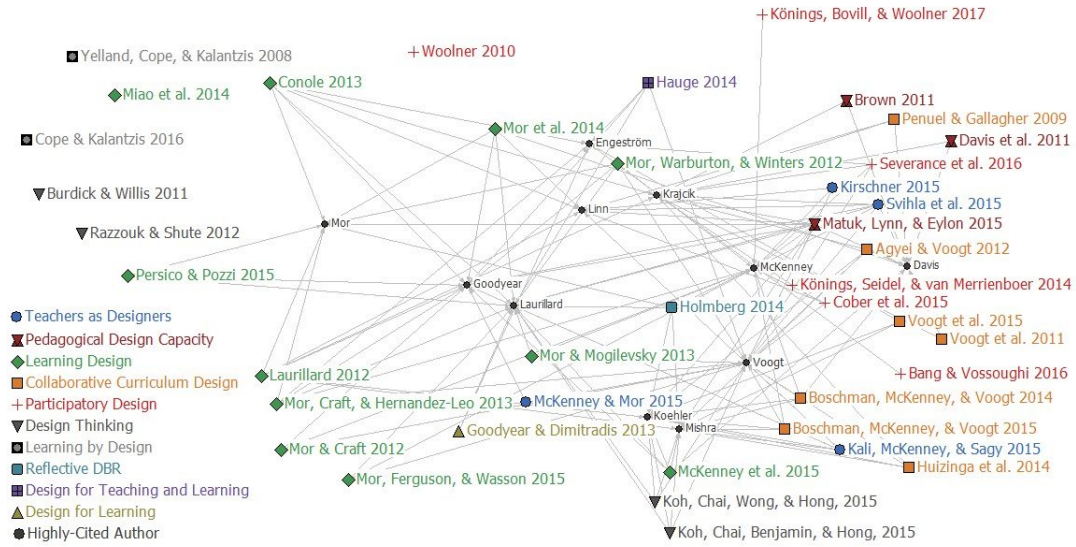
Note. Single-node clusters were manually positioned next to strand identified through content analysis. Size of text reflects number of publications by author and strand.

Figure 3 shows the strand names overlaid on the co-author network map. To provide a clear visual, solo authors were manually moved into the map based on results of the content analysis.

Question 2: How are the strands conceptually related?

The co-author network and content analyses provided an initial model of 10 strands of scholarship on teachers and design. However, the co-author map is limited because it only includes authorship data from the 40 publications analyzed and may highlight social relationships more strongly than conceptual relationships. The content analysis supplemented the co-author map by providing descriptions of the constructs of each cluster. However, neither method illustrated the conceptual or theoretical relationships across clusters, thus presenting a relatively discrete picture of the strands rather than the complex, overlapping discourse structures more typical of academic literature.

Figure 4
Citation Network Analysis Map



Note. The citation network analysis map was built using UCINET NetDraw software (Borgatti, 2002). Nodes include each publication and each cited author; directional edges were constructed from the publication to each cited scholar. Layout was initialized through Gower Scaling and optimized with 100 iterations of spring embedding (based on edge length; see Hanneman & Riddle, 2005). For readability purposes, nodes (and corresponding edges) of scholars with fewer than 25 citations are hidden. Nodes were coded based on strand identified through interpretive content analysis.

To address these limitations, we analyzed citation practices. Citations reflect the concepts and theories authors draw upon, so publications that cite similar scholars can be considered theoretically related (Krippendorff, 2019). Citation analysis also incorporates more data because it considers every scholar that each publication cites.

Figure 4 maps each publication to the scholars cited. This process resulted in 3,953 total edges. Each edge connected one publication to one of 935 cited scholars. The distances and spatial positioning of the nodes provide a representation of the citation-based conceptual connectedness across publications. For viewing clarity, only scholars with at least 25 citations are visible in Figure 4, although the algorithm, and thus the spatial placement of each publication, reflect all 3,953 edges. Although some publications appear completely disconnected from the rest of the literature, they are connected by some citations. For example, Yelland et al. (2008) cited seven scholars that were also cited by other

publications, and Cope and Kalantzis (2016) cited 45 shared scholars. However, the connecting scholars had fewer than 25 total citations and so the corresponding nodes and edges are not visible in this representation.

In Figure 4, publications colors and symbols represent the strand identified through content analysis. Most of the publications are near other publications in the same construct, providing validity for the previous analyses. However, the citation analysis map shows a more nuanced view of the relationships across publications. Rather than distinct clusters, it provides information about the *conceptual* or *theoretical connectedness* of the publications. Specifically, it demonstrates two relationships: the conceptual relationships of the constructs and the specific scholars that connect them.

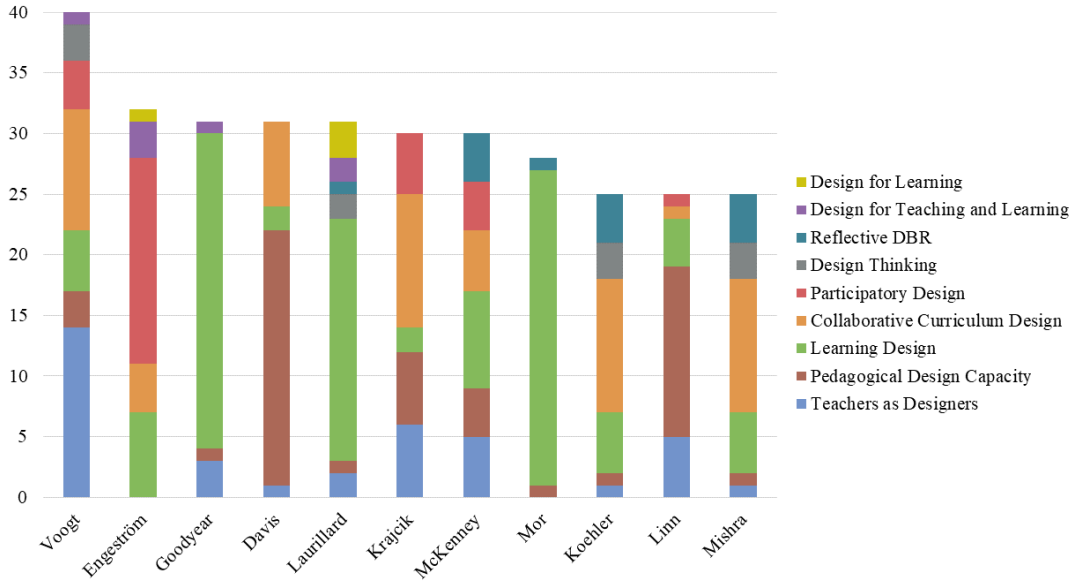
Relationships of clusters. First, Figure 4 demonstrates cluster relationships and overlaps. Most notably, *Pedagogical Design Capacity* publications overlap *Participatory Design*, *Collaborative Curriculum Design,* and *Teachers as Designers*. *Teachers as Designers* is an umbrella term that was expected to spread across other strands. *Pedagogical Design Capacity, Participatory Design*, and *Collaborative Curriculum Design* emphasize designing in authentic contexts (inside schools) through participatory and collaborative processes. Furthermore, in both *Participatory Design* and *Collaborative Curriculum Design*, teachers and researchers work together to design curriculum and, in the case of *Participatory Design*, educational systems.

Figure 4 represents the *Design Thinking* articles in two groups: Koh and colleagues' work, and the two other *Design Thinking* publications (Burdick & Willis, 2011; Razzouk & Shute, 2012). Both groups are near *Learning Design*, with Koh's work also near *Collaborative Curriculum Design*, suggesting a related emphasis. Koh, Chai, Wong, and Hong's (2015) work discussed design thinking for the development of teacher professional knowledge, a theme running throughout the *Collaborative Curriculum Design* strand. The other *Design Thinking* articles (Burdick & Willis, 2012; Razzouk & Shute, 2012) focused on general design thinking skill development.

Connecting scholars. In addition to showing the relationships among strands, the citation network map in Figure 4 also highlights key scholars that are cited both within and across strands,

visually illustrating the relationship of these scholars and the strands of research on teachers and design. Figure 5 provides additional detail on the most cited scholars.

Figure 5
Citations by Strand for the Most Cited Scholars



McKenney, Voogt, Laurillard, and Goodyear are central connectors across strands. McKenney is represented in both *Teachers as Designers* and *Collaborative Curriculum Design* strands. Her work bridges curriculum development and teacher professional development, particularly with regards to technology (McKenney, 2019). Voogt's research focuses on how co-design of ICT can lead to more effective use of ICT in the classroom (University of Amsterdam, 2019). She also studies ICT and curriculum development. Laurillard's (2012) book on the science of design is an often-cited resource for the *Learning Design* strand, placing her at the center the strand. *Learning Design* authors also frequently cited Goodyear and Mor.

Davis and Engeström were also highly cited in the literature. Davis works at the intersection of teacher learning, elementary science education, and the use of curriculum materials (University of Michigan, n.d.). She is cited by both *Collaborative Curriculum Design* and *Pedagogical Design Capacity* strands, suggesting a connection between designing curricular materials and their enactment. Engeström

connects the work in the top section of the map, reflecting a common theoretical basis for authors in the *Learning Design* and *Participatory Design* strands. Both strands draw upon an activity theory framework to explain the relationship between designer, designed artifact, and context.

Towards the middle of Figure 4 are four additional scholars who, although not authors of any of the core literature analyzed, were cited widely across the literature. These connecting scholars include Mishra and Koehler (design and technology integration), Kracjik (project-based learning), and Linn (technology integration for science and math learning). The work of these scholars suggests a conceptual thread connecting the strands of literature: each scholar coupled design with the active construction of knowledge. For example, Mishra and Koehler (2006) applied design to develop technological pedagogical content knowledge. By designing uses of technology for learning, teachers develop a specific type of knowledge that supports technology integration. In Kracjik's project-based learning, students develop knowledge through creating artifacts that are "representations of the students' problem solutions" (Blumenfeld et al., 1991, p. 372). Linn focused her work on designing for knowledge integration, "a dynamic process where students connect their conceptual ideas, link ideas to explain phenomena, add more experiences from the world to their mix of ideas, and restructure ideas with a more coherent view" (Bell & Linn, 2000, p. 797).

The citation analysis demonstrates the connections across scholars and strands. It demonstrates that the work around teachers and design generally clusters in two areas: *Learning Design* (anchored by Laurillard, Goodyear, and Mor); and *Collaborative Curriculum Design*, *Participatory Design*, and *Pedagogical Design Capacity* (anchored by Voogt, Davis, and Krajcik). McKenney's work provides somewhat of a bridge between the two clusters. Other work, such as Cope and Kalantzis's *Learning by Design*, is not cited at all by the publications in this analysis. These divisions suggest we may be missing key insights that could be realized by reading more broadly across strands.

Question 3: How does each strand apply design to teachers' work?

Responding to question 1 and 2 provided (a) 10 strands of research and (b) a map of conceptual relationships among the strands and cited scholars. As we analyzed the data, we noticed the strands often spoke of the *act* of design in different ways. In question 3 we seek to better understand the

application of design in each strand. Specifically, we ask the questions: *What is designed? Who does the designing? When does the designing happen? What is the role of teachers in the process? Why should we frame teachers as designers, and what are the expected outcomes of such a stance?*

A second read and analysis of the literature provided insight into these questions. Table 2 describes the results.

Table 2

Teachers as Designer Descriptions by Strand

Strand	Strand	What	Who	When	How	Why
1	Teachers as Designers	Primarily technology-enhanced learning	Teachers, sometimes diverse stakeholders	Throughout teaching process	Varies	Integrate technology, professional growth, more effective instruction
2	Learning Design	Artifacts describing effective patterns for units, lessons, etc.	Teachers, researchers	Creating and evaluating learning objects	Sometimes in teams	Create a system of sharable artifacts, professional growth
3	Collaborative Curriculum Design	Units, lessons	Teachers, researchers, subject matter experts	Creating learning resources and planning lessons	In teacher teams assisted by researchers	Professional growth, effective implementation of new curriculum
4	Participatory Design	Curriculum, school buildings, artifacts	Teachers, researchers, students, community	Creating learning objects and resources	Multi-stakeholder teams	Give teachers equal voice, create more effective designs that reflect realities of practice
5	Design Thinking	Lessons, units, artifacts, learning environments	Teachers	Pres-service teacher education and creating resources	Varies	Create new approaches to education
6	Pedagogical Design Capacity	Adaptive instruction	Teachers	Lesson planning and instruction	Individually, often while teaching	Reflect on and evaluate practice
7	Learning by Design	Instructional framework	Teachers	Lesson planning, instruction, and evaluation	Individually or in teacher teams	More effective lessons, professional growth
8	Reflective DBR	Development of intervention or artifact	Teachers with research support	Creating learning objects, lesson planning, instruction, and evaluation	Teachers and researchers reflect on design process	Improve research-practice connection
9	Design for Teaching and Learning	Opportunities for learning	Teachers, learners	Design for Teaching: lesson planning and evaluation Design for Learning: instruction	Varies	Align (or understand connection between) teaching and learning
10	Design for Learning	Learning experiences: tasks, social and physical architecture	Teachers	Creating objects and resources, lesson planning, assessment and evaluation	Varies	Address complex educational problems in sustainable ways

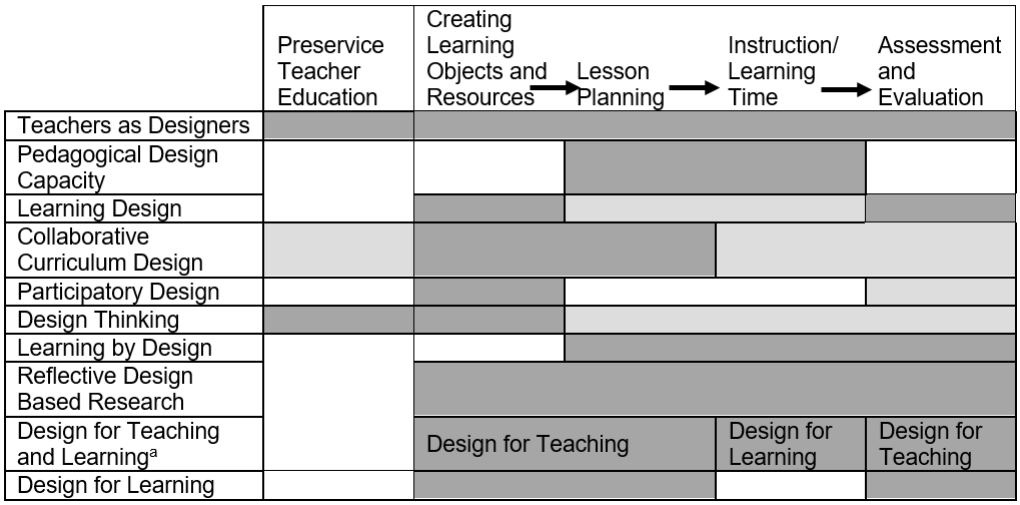
Each strand applies design to different aspects of teachers' work. They describe various combinations of *what*, *who*, *when*, *how*, and *why* teachers design. For instance, *Learning Design* focuses on teachers designing artifacts that outline specific patterns or methods for teaching. Teachers and researchers design these resources, sometimes in teams and sometimes individually, and the design process leads to new curricular methods and professional growth. In *Participatory Design*, on the other hand, diverse stakeholders (community members, business leaders, teachers, students, etc.) design a variety of learning tools or resources in a collaborative approach aimed to disrupt existing power structures.

Across the strands, teachers design instruction, learning tools, learning patterns, curriculum, lesson plans, enactment of lessons, and learning experiences. Teachers are described as designing with researchers, but also design with students and the community. They design independently or in teams. Finally, each strand has different reasons for framing teachers as designers. Design practice can lead to professional growth for teachers, improved instruction, a tighter connection between research and practice, better instructional tools, more effective technology integration, and, in participatory design, a stronger voice for teachers.

Perhaps one of the most effective ways to summarize the differences across strands is to consider each strand's description of *when* design happens. The literature applied design to various parts of teachers work, from pre-service teacher education to assessment and evaluation of instruction (see Figure 6). *When* design happens corresponds with *what* is designed and *why* consider teacher's work as design. For example, where the focus is on creating curriculum or learning objects, design work is partly conducted outside of the instructional planning process, such as in *Collaborative Curriculum Design, Learning Design, Participatory Design,* and *Design for Teaching and Learning.* Where teachers' work adapting and revising learning materials for classroom use is considered design, literature focuses on the planning and implementation stages, such as in *Pedagogical Design Capacity*. When design is considered as a tool for developing professional expertise, it may spread across many parts of teachers' work, as highlighted in *Teachers as Designers* and *Collaborative Curriculum Design.*

Figure 6

Comparison of When Teachers Design by Strand



Note. Dark shaded boxes indicate emphasis of strand. Lightly shaded boxes highlight time periods when design practices may also occur according to the strand literature.

[a]Hauge (2014) separated "design for teaching" from "design for learning." "Design for teaching" occurs as teachers plan how they will structure the environment for learning and evaluate the results, while "design for learning" happens *with* students as they co-construct new understandings.

If design work can be used as a professional learning tool, incorporating design into teacher education could be particularly effective. In the next section, we discuss implications for both teacher professional knowledge and teacher education.

Discussion

We started this paper with the question "What does it mean for a teacher to be described as a designer, or for the act of teaching to be considered an act of design?" Our analysis offered a map of the landscape of key literature on teachers and design. It highlighted the disparate ways teachers and design has been discussed and interpreted.

In this section, we revisit each research question considering both our analysis and the 2018 BJET special issue discussed in the introduction. Our analysis suggests that teaching not only includes design activities but could be considered a *design profession* in which both teaching/learning artifacts (uses of technology, curriculum, lesson plans, enacted lessons, etc.) and professional knowledge are constructed through design. We then explore the implications of

this position by considering knowledge construction and pedagogical practices of other design professions.

First, our attempt to answer research question one ("What are the strands of scholarship that describe teachers as designers?") highlighted the broad definitions and interpretations of teachers as designers, akin to Persico et al.'s (2018) observation of blurred definitions and multiple interpretations on teachers and design. We believe our work provides some clarification by identifying 10 strands of related work. The BJET special issue most closely aligns with *Learning Design*, and two of the top cited authors in this analysis—Goodyear and Laurillard—are authors of work in the special issue. However, our analysis identified other areas that discuss teachers and design. For instance, several other authors—including Voogt, McKenney, and Davis—explore the idea of teachers as designers from other perspectives. Integrating the perspectives on teachers and design might increase the impact of the scholarship, and more importantly, might allow for a comprehensive understanding of what it means for teachers to be designers.

Research question two explored how the 10 strands are conceptually related. We used a network analysis of citations (Figure 4) as well as explored the citation patterns of highly cited scholars (Figure 5) to identify two core groups: (1) *Learning Design* on the left of Figure 4 and (2) the overlap of *Collaborative Curriculum Design*, *Participatory Design*, and *Pedagogical Design Capacity* on the right.

We discussed the relationships among scholars and the strands of literature. Of particular interest here is the four scholars (Mishra, Koehler, Linn, and Kracjik) who were not authors in the literature but were cited across strands. Their work reflects an epistemological stance that views knowledge as fluid and actively constructed through experience. This knowledge can be represented, shared, and built upon through design. Their epistemology mirrors a design epistemology as described by Cross (2006; 2018) and Schön (1983).

Our answer to research question three (how each strand applies design to teachers' work) connects this design epistemology to teaching practice. The "why" column of Table 2

suggests that viewing teachers as designers not only enables the creation and sharing of artifacts but also supports the development of professional knowledge. The strands framed teachers as designers to promote professional growth, develop knowledge, and integrate research and practice. In each case, professional knowledge is constructed in a way that supports direct application to practice. Design is useful not only because it results in teaching/learning artifacts, but because the very process of design develops integrated professional knowledge.

Although most of the strands discussed design and the development of professional knowledge, descriptions of *when* this occurs vary. Figure 6 adds clarity by illustrating each construct's description of when design happens. Viewed together, the strands illustrate design as spanning the entire teaching process, suggesting design is the central activity of teachers. This, coupled with the design-like epistemological perspective that connects the literature, suggests that *rather than a practice that includes design activities, teaching can be considered a design profession.*

The idea of teaching as a design profession has implications for both teacher education and practice. Importantly, teacher education from a design perspective would center on developing teaching/learning artifacts *and* professional knowledge through design. We believe that there are a few important consequences that emerge from taking on this perspective.

First, we can look at the educational methods of other design professions, consider the principles behind the methods, and apply these principles to teacher education. For example, the foundation of architectural education is the studio course, an experience centered on an authentic project students address with instructor support. Studio pedagogy is similar to project-based learning, but design studios also emphasize reflective practice (Schön, 1987). Instructors help students develop their own understandings through continually creating and reflecting on representations.

A studio approach is not new to teacher education. Mor and Mogilevsky (2013), among others (e.g., Jordan, 2016), described design studios in pre- and in-service teacher education. Although studio courses might be useful in teacher education, we are not calling for duplicating

the structure of studio courses. Rather, we would like to consider the epistemological and pedagogical principles *behind* studio approaches, the principles that support education in design professions. The authentic, project-centered, and reflective characteristics of studio courses develop knowing akin to Perkins's (1986) idea of "knowledge as design:" knowing and practice is built around context and needs. In Glanville's (2006) terms, it is "knowledge for" practice rather than only "knowledge of" practice. The power of "knowledge for," or knowledge designed for particular use, is it can be continually adapted and molded based on context. For example, much of the literature focused on teachers designing for technology-enhanced learning. Technologies change over time, and by developing design strategies for incorporating new technologies, teachers can become flexible and effective not just at capitalizing on new innovations, but also at continually sculpting their professional knowledge to fit new contexts.

To support teaching as a design profession, teacher education should center on designing and reflecting on teaching/learning artifacts. Flexible and adaptable professional knowledge develops through reflection in and on design rather than through accumulation and application of theoretical knowledge (Schön, 1987). As designers, teachers need this type of flexible and adaptable knowledge to successfully navigate complex contexts.

Limitations

In this article, we have attempted to identify and analyze the idea of teachers as designers across the academic literature. This analysis was particularly complicated because (1) the idea of teachers as designers is broad and spans different lines of work, and (2) the term design itself is frequently used in ways that do not apply to the topic. Identifying and analyzing the literature called for a combination of tailored approaches. Although we believe our methods were appropriate for the goals and scope of this analysis, there are several limitations discussed throughout the manuscript.

For example, the use of citation counts is problematized by the fact that citations are not perfect indicators of impact or theoretical relatedness, and the citation cut-off points were selected based on the number of literature items to be collected. Additionally, limiting the original

search to title words could have impacted the results (see Methods section). Nevertheless, given the wide use of the word *design* in academic literature, the approach overcomes limitations of other literature selection methods that would conflict with the core goals of this analysis. For example, if we had focused on a type of snowball approach (where publications are identified through references), it would have defeated the primary aim of this work: to identify less connected strands of research.

Additionally, we used citation data to visualize conceptual relatedness among strands. This approach assumes citations index theoretical similarity. This is not always true; citations can also be used to highlight differences. However, such use of citations is the exception rather than the norm, and in general citation patterns suggest some theoretical alignment (see Krippendorff, 2019).

Future analysis of the literature might include a geographical analysis of authors and institutions. Additionally, including multiple independent analysts might offer additional insight. Finally, a detailed exploration of each strand is warranted.

Conclusion

In this article, we have provided a broad context for understanding the constructs of teaching and design, providing scholars who use these terms a better understanding of both the similarities in their approaches and the differences among them. Our work suggests that viewing teaching not just as a practice that includes design tasks but as a design profession, where design supports the construction of both teaching/learning artifacts and professional knowledge, has significant value. Teacher education should focus on developing professional knowledge through design so that this knowledge becomes creative, fluid, and adaptable, able to be molded to the needs of particular contexts. A design paradigm supports this approach; it offers a holistic perspective on who teachers are and what they do. It provides a framework for teaching in complex and ever-changing contexts.

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CHAPTER 3

"BRINGING IN THE SELF": TEACHERS, DESIGN, AND SENSEMAKING

Interlude

In chapter 2, I presented an analysis of a decade of literature on teachers and design. I illustrated how teachers have been described as designing across all phases of their practice. If design is prevalent across teaching practice, it stands to reason that teachers should be educated as designers. Thus, I created a design-based professional development program and implemented it with four teachers in a rural junior high school. In this article, I present a case study analysis of the implementation of the program, including how the program led to an unexpected outcome: that the design approach supported teachers in personal sensemaking.

Introduction

Teaching is a deeply personal profession. It is less clear, however, how teachers integrate their passions, interests, experiences, and knowledge into their professional practice as situated in a complex context. In this paper, I explore this idea by describing the experiences of teachers in a rural junior high school as they engaged in a design-based professional development (PD) program.

The PD program described here was based on the idea of seeing teachers as designers. The initial conceptualization focused on providing teachers a range of tools and techniques that could help them develop designerly mindsets. The underlying goal was to encourage teachers to make changes to a situation and reflect on the results. This is not a new idea, per se, since teacher educators often focus on reflection as a way to support situated professional development, claiming reflection can help teachers connect theory and practice (Clarà, 2015; Zeichner & Liu, 2010). The reflection literature often cites Donald Schön's (1983) reflection-in-action as a central theoretical construct (Zeichner & Liu, 2010). According to Schön (1992), reflection is a type of "reciprocal inquiry," (p. 123) and reflection-in-action describes reflection that happens while the situation can be changed by the reflector.

Much of Schön's work focused on reflection as it occurs in design practice. Unsurprisingly, Schön is also frequently cited in strands of literature that frame teachers as designers (Warr & Mishra, 2021). However, whereas the teacher education reflection literature primarily focuses on connecting personal experiences to broader theory, the literature on teachers and design centers on the development of professional knowledge through designing professional products (for example, lesson plans or curriculum).

There are others who have argued that the construct of reflection-in-action itself is limited because it diminishes the symbiotic relationship between the designer and the designed. For example, Jahnke (2011, 2012) is critical of what he claims is reflection-in-action's "inert self" view of the designer as well as the lack of attention it gives to the context design occurs in. Instead, Jahnke argued for a critical hermeneutic perspective that recognizes the dynamic relationship between the subject, object, and larger context in the act of design. Thus, Jahnke argued that it is not just the object that changes through the process of design, but the subject (the designer) is changed as well. Design, according to this perspective, becomes an act of personal interpretation, a way to make sense of the past and future amidst a complex context, and ultimately changes the designed *and* the designer.

The emphasis on personal interpretation in Jahnke's (2012) hermeneutic design is similar to the idea of sensemaking (Brown et al., 2008; Weick, 2005). Sensemaking is a process of (re)interpreting the past in a way that impacts future action. Weick (1995) described, "Sensemaking is about the ways people generate what they interpret" (p. 13).

In this paper, I explore design and sensemaking through describing teachers' experiences at a rural junior high school as they engaged in a design-based (PD) program. The PD program was designed to help teachers discover creative ways to address self-selected problems of practice. The program took an unexpected turn when the school building was closed due to the COVID-19 pandemic in March 2020, with significant consequences to the content and delivery of the program. For instance, problems of practice that focused on face-to-face teaching had to change given the move to remote learning. The delivery of the PD program was also

moved online, requiring significant changes to the initial plans. Despite these changes, analysis of the data revealed that the teachers found their experiences in the program beneficial in unique and personal ways. Specifically, the teachers brought professional and personal identity, beliefs, experiences, and passions—what one teacher called “bringing in the self”—into the workshops, resulting in a type of sensemaking (and hermeneutic design) that supported the teachers in a difficult period of time.

I argue that the case highlights the special role that design-based approaches can play in supporting the integration of the personal and professional lives of teachers within a specific context. Specifically, the concept of hermeneutic design and sensemaking provides a direction for deepening the understanding of reflection and design in teacher education, providing a new paradigm for teacher education and practice. The design approach supports integrating the professional, personal, and emotional dynamics of teaching in a way that is responsive to context.

In what follows, I first describe key theoretical arguments by reviewing literature on reflection, teachers as designers, design, sensemaking and epistemic diversity. Then I describe the research methods and findings of the case study of a design-based professional development program. Finally, I connect the findings of the case study back to the literature on professional learning, teacher education, and reflection, arguing that design offers teachers a way of working and learning that is responsive to complexity and that integrates personal and professional experiences, beliefs, and emotions in a future-oriented way

Theoretical Background

The argument put forth in this paper—design is a type of sense-making that can help teachers integrate the personal and professional amidst a particular context—builds on a wide array of literature, including reflection, teachers as designers, design, and sensemaking. After discussing each of these areas, I turn to a concept at the center of the PD program implemented in the case study: epistemic diversity.

From Reflection to Teacher Designers

Reflection has played a central role in the teacher education literature for over three decades (Clarà, 2015; Hatton & Smith, 1995; van Manen, 1995). Clara (2015) defined reflection as “a thinking process which gives coherence to a situation which is initially incoherent and unclear” (p. 263). Hatton and Smith (1995) as well as Clara (2015) cited John Dewey and Donald Schön as key theorists on reflection. Indeed, Dewey’s writings informed Schön’s (1992) work on inquiry and reflection. Schön spent most of his career as a professor in urban planning at Massachusetts Institute of Technology, where his transdisciplinary work explored professional learning, invention, inquiry, and organizational learning (Waks, 2001). Of interest here is his exploration of professional education. In 1983, Schön described a “crisis of confidence” (p. 5) in professional knowledge where professional judgment is undervalued under the dominant model of technical rationality. In technical rationality, researchers and academics develop theory which practitioners apply to practice. However, rather than viewing practitioners as those who carry out the theories of others, Schön saw practitioners as designers, or those who “make things out of the materials of a situation under conditions of complexity and uncertainty” (Schön, 1992, p. 126). Conditions of complexity—such as the complexities of supporting learning in a diverse classroom—make direct application of externally-created theory difficult, and professionals often rely on understandings of patterns or models, making decisions based on past experiences as well as ongoing feedback from the situation. Schön (1983) called this professional action “reflection-in-action,” where professionals create a “theory of a unique case” (p. 68), continually acting in the context and adjusting actions based on how the situation “talks back.” This way of working and understanding is an “epistemology of practice” (p. 69), and “an epistemology of practice must be an epistemology of designing” (Schön, 1992, p. 127).

Schön’s description of practitioners as designers applies to teachers, a group of practitioners he often explored in his writing (e.g., Schön, 1987). Teachers “make things” (lesson plans, worksheets, classroom procedures, classroom culture—ultimately opportunities for learning) “under conditions of complexity and uncertainty” (Schön, 1992, p. 126). Recent literature

on the difficulties of being a teacher has only served to emphasize the complexity teachers work in, including an increasingly heterogeneous student population (Day, 2012), political and professional strife (Day, 2012), an influx of technological advances (Holmberg, 2014), the need to prepare students for an ever-changing future (Burdick & Willis, 2011), and the difficulties of supporting learning and navigating uncertainty in a global pandemic (Anderson et al., 2020).

Many scholars have framed teachers as designers, and an analysis of the literature on teachers and design highlighted a complex and expansive view of how teachers design and the value of framing teachers as designers (Warr & Mishra, 2021). Importantly, design-centered teacher education literature has focused on design as both a way for teachers to engage in professional activities and develop professional knowledge that supports working in their particular complex context. A design approach to teaching can support confidence and empowerment (Agyei & Voogt, 2012; Henriksen et al., 2017; Stolk et al., 2011), ownership of reform (Agyei & Voogt, 2012; Hickey & Itow, 2012; Voogt et al., 2015), development of knowledge and skills (Agyei & Voogt, 2012; Chien et al., 2012; Hathaway & Norton, 2018; Jordan, 2016; Voogt et al., 2015), learning that is connected to practice (Hathaway & Norton, 2018; Jordan, 2016; Stolk et al., 2011; Voogt et al., 2015), and changes in beliefs and pedagogy (Miao et al., 2014; Voogt et al., 2015; Yelland et al., 2008).

The PD program described in this article further explored teachers and design, with an initial goal of investigating the relationship between teachers, design, creativity, identity, and professional knowledge. As will be described, it was found that the program supported teachers in making sense of a difficult period of time, provided multiple ways of understanding their work. The creative design approach supported not just the development of professional knowledge, also but supported teachers in personal sensemaking amidst complexity.

From Design to Sensemaking

Perhaps one of the most significant affordances of framing teachers as designers is that it provides a way to think about the way teachers work in complex contexts. Schön, as well as several other scholars (e.g., Simon, 1969) equated design with professional action because of its

embeddedness in complexity and particularity. Nelson and Stolterman (2012) explored the relationship between design and complexity in more depth, describing design as “based on a compound inquiry, composed of true, ideal, and real approaches to gaining knowledge” (p. 34). Whereas scientific theories are meant to apply across multiple contexts (they can suggest what is true), and the ideal by definition is rarely achievable, the designer creates the real. The real is an “ultimate particular” (Nelson & Stolterman, 2012, p. 31), it is something made for a specific context; it is adapted to a purpose (see Perkins, 1986). Focusing on the creation of the real allows the navigation of complex contexts. This is not to say that designers are not interested in the true and ideal; the true and ideal support the inquiry process. However, what is unique in design is its focus on creating the real and particular in complexity.

Design is not just about creating things; Nelson and Stolterman (2012) as well as other design scholars (e.g., Cross, 2006; Jahnke, 2012; Redström, 2017) described design as a type of inquiry because it supports a way to come to know. This can be seen in Schön’s work connecting design with professional education. Jahnke (2012) extended Schön’s theory of reflection-in-action through philosophical hermeneutics, including the work of Gadamer, Ricoeur, Habermas, and Jaspers, to illustrate the relationship between design and meaning making. Hermeneutics originated in the interpretation of religious texts but has expanded as a tool for conceptualizing interpretation in general. It explores how meaning is developed through an iterative consideration of whole and parts (the hermeneutic circle). Philosophers have discussed the role of historical context and personal biases on interpretation. Jahnke (2012) focused his work on Ricoeur’s critical hermeneutics, which emphasized the use of distancing to expand interpretation, including applying a type of poetic redescription to open up possibilities for meaning. New meaning forms a type of “proposal” that undergoes further interpretation, potentially leading to an emancipatory process. The result is not just a practice of interpretation, but of creation of meaning that is situated in evolving situations and in which the self evolves through the process, with the resulting design being a manifestation of that evolution.

An interpretation of design as the creation of meaning is akin to sensemaking as described by Weick (1995) as well as others (e.g., Brown et al., 2008). Brown et al. described sensemaking as “a generic phrase that refers to the process of interpretation and meaning production whereby individuals and groups interpret and reflect on phenomena” (p. 1038). Sensemaking moves beyond interpretation to include not just reconsidering the past but producing meaning that affects the future. In Weick’s (1995) words, sensemaking combines “interpretation and authoring,” “discovery and creation” (p. 8). It connects the past and the future: “it can be constructed retrospectively yet used prospectively” (Brown et al., p. 1038). Like design, it is an organization of meaning that impacts the future.

Sensemaking is sparked by disruption, puzzlement, or ambiguity. The sensemaker selects which pieces of the situation to attend to and creates an explanation that is plausible. The plausible explanation allows them to move forward, though they might revise their explanation based on the results. This means sensemaking is not about perceiving a situation accurately; it is about creating a way to understand the past that allows the sensemaker to make progress towards long-term goals. Important to the explorations here, the plausible explanation is developed in response to the context the sensemaker is working in.

A critical feature of sensemaking is its relationship to identity and identity construction. People make sense in a way that meets their personal needs for self-esteem, self-efficacy, and self-consistency (Brown et al., 2008). At the same time, sensemaking interacts with and affects identity (Weick, 2005). In other words, sensemaking is both influenced by and influences identity. The dynamic between sensemaking and identity can explain why individuals interpret the same experience differently—they are creating an understanding impacted by their identity (Brown et al., 2008; Helms-Mills, 2003).

Epistemic Diversity

The PD program described here is based on the concept of epistemic diversity. Both design and sensemaking require the designer (or sensemaker) to see a situation in a new way—a way that enables a fresh interpretation. This is akin to Jahnke’s (2012) reference to Ricoeur’s

“poetic redescription” (p. 34). Designers have been described as “bricoleurs” (Fallman, 2003) and hydra-headed (IIT Institute of Design, 2009) because they combine whatever tools or approaches are available in a pragmatic way. They often “take on multiple views” and “possess a compound eye” (Fallman, 2003, p. 227). This is part of what allows them to excel in complexity. They practice epistemic diversity.

The term *epistemic diversity* emphasizes the value of multiple ways of knowing, along with the power of coming to know from multiple perspectives. Gobbo and Russo (2020) defined epistemic diversity as “the ability or possibility of producing diverse and rich epistemic apparati to make sense of the world around us” (p. 186). They argued that rather than knowledge focusing exclusively on a “correspondence” with the world (as typically presented in scientific or propositional knowledge), knowledge could be considered “the right sort of *connections* [emphasis added]” (p. 189). Epistemic diversity emphasizes the value of connecting propositional knowledge with the complex and particular world of emotions and experiences, ultimately offering new ways of making sense in the particular.

Central to the design approach applied here is the use of creativity as an epistemic tool. I draw on a sociocultural and ecological perspective on creativity. For example, Glăveanu (2013) described creativity as “concerned with the action of an actor or group of actors, in its constant interaction with multiple audiences and the affordances of the material world, leading to the generation of new and useful artifacts” (p. 76). As such, creativity could be seen as involving the the integration of five A’s: actor, action, artifact, audience, and affordances (Glăveanu, 2013). It is the ongoing interaction across these elements that support a creative epistemic perspective. For example, creating, sharing, and reflecting on various representations of ideas can support the development of new ways to see or understand an idea. This is akin to what Beghetto and Kaufman (2007) label as “mini-c” creativity, or creativity as the development of personal understanding and insight.

In the case described here, I encouraged teachers to practice epistemic diversity through various “mindsets” or ways of knowing. Rauth et al. (2010) suggested that mindsets “shape an

epistemological view and a methodology for learning" (p. 3). I created the mindsets used in this study through a review of design literature as well as an analysis of focus group interviews where teachers described core activities of their practice. I will describe the mindsets applied in this case in more depth below. First, however, I turn to the methodology and method used to understand this unique case of design-based professional development and the connection between design, sensemaking, and epistemic diversity.

Methodology and Method

This paper describes how a professional development program supported teachers in a design-centered interpretive process amidst complexity, resulting in new understandings and related shifts in beliefs about teaching and learning. I applied an explanatory case study approach (Yin, 2017) to gain a better understanding of what happened in this unique case of a design-based professional development program implemented during the COVID-19 pandemic.

Case Study Method

Case study research focuses on a "technically distinctive situation in which there will be many more variables of interest than data points" (Yin, 2017, p. 15). Other hallmarks of case study research include the use of multiple forms of data, analysis guided by theoretical propositions, and analytic generalization. The case is not a sample of phenomenon; rather, it offers "the opportunity to shed empirical light on some theoretical concepts or principles" (Yin, 2017, p. 38).

This analysis applies an explanatory case study method to understand a revelatory case (Yin, 2017). Specifically, the unexpected interruption in the PD program provided an opportunity to explore the interaction of the teachers' context and design, providing an example of how design-based professional development can support sensemaking particular to a shifting context. The single case is bound by time (January 2020 to July 2020), activity (design workshops and associated activities), and participants (the author who facilitated the program and the four participating teachers). As will be described in more detail below, participants were treated as embedded sub-units within the single case.

Overview of Context and Participants

The case analyzed here was the implementation of a design-based professional development program that occurred from January 2020 to July 2020 in a rural Title 1 junior-senior high school in the Southwest United States which here I will call Mountainview Junior High (JH). In 2019, 54% of students at Mountainview JH qualified for free or reduced lunch. The student population was 53.4% Hispanic, 40.9% white, and 13.6% Native American, and the school included 156 students in grades 7 and 8. At the time of this study, the school also included students in grade 6 for approximately 240 total junior high students.

The school had participated in previous professional development projects with the coordinating university, and the school principal paid four teachers to participate in the PD program. To select participants, I conducted initial interviews with six teachers. At the conclusion of each interview, I explained the program and invited the teachers to participate. The first four teachers who committed to participate were included in the study.

Three teachers participated in the full program (January to July), and one (Lisa) participated from January to June. The teachers varied in age, teaching experience, cultural background, and subject area (see Table 3, all names are pseudonyms).

Table 3

Professional Development Program Participants

Name	Subject Area	Teaching Experience
David (M)	Math	2 years
Virginia (F)	English	20 years
Ana (F)	Math	12 years total; 2 years in the United States
Lisa (F)	Science	1 year

The PD program focused on supporting teachers as designers as they addressed a self-selected problem of practice. The original plan for the program was to conduct eight two-hour workshops from January to May 2020. However, as was true for much teacher education

research conducted during 2020, the COVID19 pandemic led to significant shifts in format and content.

The enacted program consisted of three in-person workshops (two hours each) occurring in January and February 2020, followed by 18 online workshops (one hour each) from April to July 2020. In the workshops, teachers discussed professional challenges and explored ways to address them, including participating in creative activities to encourage divergent thinking. I scaffolded the explorations through mindsets, each a way of seeing and interacting with the problem-solution space (see Table 4; these will be illustrated in more depth later in the article). For example, between many of the sessions I provided teachers with a list of potential activities they could engage in from various mindsets, such as reviewing research literature related to the problem space (analytic), interviewing students (empathetic), creating a metaphor for an idea (creative), or writing a poem about a related experience (aesthetic). During the PD sessions, teachers shared their work and we reflected on the results.

As the supporting teacher educator, I led teachers through creative activities, asked questions to encourage discussion of ideas, shared resources and literature related to their selected challenges, and encouraged them to make action plans. To be responsive to the emergent needs of the teachers during the pandemic and the move to remote learning, I also modeled the use of various educational technology programs.

Table 4

Mindsets and Moves of Design

Mindset (Be)	Moves (Act and Understand)	Learn about, think about, interact through:
Experimental (Action)	Test, Try, Prototype, Model, Attempt, Iterate	Sketching and prototyping
Reflective (Inquiry)	Reflect, Interpret, Consider, Wonder, Judge	Metacognition on evidence, experiences, and beliefs
Empathetic	Understand, Observe, Discern, Examine, Discover	Others' experiences and emotions
Analytic	Investigate, Study, Explore, Research, Evaluate, Assess	Empirical research (others' and own)
Creative	Generate, Ideate, Brainstorm, Conceive, Gestate	Divergent thinking (including metaphor)
Aesthetic	Sense, Unify, Enhance, Beautify, Refine, Judge	Senses, emotions, patterns, own experiences

Note. Experimentation and reflection can be thought of as meta-perspectives. They occur throughout the design process and support learning and development through the other mindsets and moves. For example, the analytical mindset can be enacted through experimentation and reflection.

Data Collection

A hallmark of case study research is the use of multiple types of data (Yin, 2017). Accordingly, a variety of data were gathered throughout the research process including:

- *Workshop recordings*. Video recordings of all PD workshops and transcriptions produced from the videos
- *Initial interviews*. Each teacher participated in a 20–35-minute interview in January 2020. The interview focused on creative expressions of professional identity. At the conclusion of the interviews, the teachers shared challenges they were having in their practice and were invited to join the professional development program to address these challenges.
- *Post-interviews.* The three teachers who completed all workshops participated in 90 to 120-minute post interviews. These interviews included three parts: follow-up questions on creativity-based identity activities teachers completed before the interview, questions

about teachers' understandings of relatedness (a concept explored in the workshops), and questions about teachers' experiences in the PD workshops. The fourth teacher completed a 45-minute interview focused on her experiences in the workshops.

- *Teacher reflections and work samples*. Throughout the workshops, teachers responded in writing and/or drawing to various reflection questions, including descriptions of the problem/solution space they were designing in and how they were understanding core concepts. Teachers also shared their participation in other activities such as written summaries of research literature and creative products (such as poems and drawings). They also shared prototypes of classroom activities they designed.
- *Researcher memos*. Written and audio memos were kept throughout the study. Memo topics included theoretical reflections, literature connections, research design, workshop plans, and workshop reflections.

Data Analysis

Case study methods do not attempt to provide statistical generalization; rather they can be used for analytical generalization by exploring theoretical propositions (Stake, 1995; Yin, 2017). Yin explained that rather than a sample, a case is "the opportunity to shed empirical light on some theoretical concepts and principles" (p. 38). Thus, the focus in case study work is rigorous theoretical exploration, and validity or trustworthiness relies on careful analysis of an idea as it plays out within a case.

In this study, I used multiple sources of evidence to investigate a proposition identified through a review of the scholarly literature on teachers and design: design-based professional learning can support both the development of professional activities and context-embedded professional knowledge. As is common in qualitative analysis, surprises identified in the data led to a consideration of outcomes beyond professional products and knowledge; analysis revealed a more personal dimension of the program, shifting the focus of the analysis to sensemaking.

Yin (2017) described analytical strategies and techniques for case study analysis such as focusing on theoretical propositions, applying grounded theory approaches, developing case

descriptions, and examining plausible rival explanations, as well as techniques such as pattern matching and explanation building. In single cases with embedded units, analysis can be enhanced by considering the units together and separately (Baxter & Jack, 2008). In this study, I focused the analysis on the proposition created from a review of the literature and teachers and design and used the embedded units to explore and revise patterns (models of what the outcomes of the program were and how those outcomes came to be) and investigated rival explanations. I also engaged in extensive memo writing and created various summary tables of the data. Steps of the analysis included:

1. Reviewing all data, writing analytic memos, and constructing tables to compare participant interview responses
2. Constructing a pattern that might explain individual teacher outcomes of the program and how those outcomes were supported, and documenting plausible rival explanations
3. Reviewing the data from the perspective of a single participant, comparing their experience with the proposed pattern, and looking for evidence for and against rival explanations
4. Synthesizing the experiences of a single participant into a case description of that participant
5. Comparing the case description of each participant to the proposed pattern and to the experiences of the other participants
6. Constructing a new pattern that better models the data

I completed this cycle of pattern construction, review of data from a single participant perspective, synthesis, and revision of the pattern until the data had been reviewed from the perspective of each participant. Next, I identified pieces of the pattern that were not clear and returned to the data as a whole to clarify understandings. The process was continued until the pattern fit the data and rival explanations were ruled out or incorporated into the pattern. The initial analysis led to the basic case description presented next.

Positionality

I acted as researcher, program designer, and program facilitator for this study. Combining these roles allowed me to flexibly respond to the pandemic-disrupted context. As a former junior high school teacher, I was conscientious of any extra burden I might be placing on the teachers, particularly given the personal and professional challenges caused by the COVID-19 pandemic. Throughout the program, I asked the teachers whether our work together was helpful and attempted to adapt the program to meet their needs.

My dual roles may have impacted the data collection and analysis processes, including the responses of teachers during the interviews. I addressed this potential bias through careful analysis of multiple types of data as well as documenting and evaluating rival explanations throughout the analysis process.

Case Overview

The creative design professional development program began with four teachers in January 2020. The goal was to encourage participating teachers to see themselves as designers. This was done by highlighting how their work as teachers can be seen as design work and by enhancing their design skills. The approach focused on asking teachers to select a problem of practice then experiment with ways to address that problem by implementing partial or scaled-down solutions and reflecting on the results. The approach also emphasized the interactive nature of problems and solutions, exploring how problems and solutions adapt to each other.

The program was designed to scaffold teachers in their design work by encouraging epistemic diversity—a key aspect of how designers approach their craft. Epistemic diversity was enacted through a range of mindsets—ways to be, act, and understand—identified from a review of the literature. The program included activities across the mindsets. In May, teachers were formally introduced to the mindsets as ways to interact with the problem space.

In the first two workshops, teachers explored challenges and wonderings in their practice and together decided to focus on students' lack of respect towards adults. They often discussed this problem as a behavioral or classroom management issue. They began exploring the problem

by asking students to write letters to teachers about school. In the final in-person workshop (workshop 3), we began analyzing the student letters to better understand student perspectives on school.

After workshop 3, teachers went on spring break not knowing that they would not return to in-person teaching during the 2019-2020 school year. When COVID-19 became more prevalent in the United States, schools closed their doors for fear of spreading the virus. Mountainview JH was in a particularly difficult situation, as more than half of the students did not have access to digital devices and internet at home, so the school was unable to hold school online. Teachers worked quickly to create packets to send to students. While teachers were making the transition, I provided technical support to the school as needed. We began meeting again for PD workshops in April 2020—this time for one hour a week over video conferencing.

When we returned to our work, much had changed. Although in the early workshops, the teachers tended to emphasize behavior and "classroom management," they soon discovered that, during COVID-19, classroom management was not as salient. Rather, they puzzled over how to encourage students to complete work from home and how to keep them engaged and interested in learning.

In Workshop 5, I introduced the teachers to the idea of using the mindsets to explore ideas. I suggested activities they might engage in related to each mindset, and the teachers each selected a mindset to experiment with before the next session. Through reading literature on student engagement, one teacher learned about the concept of *relatedness* and shared it with the group. Relatedness included feeling connected to others, but personal experiences of teachers also suggested relatedness could apply to connecting personal experiences to a global context. The teachers decided to reframe their original problem (student behavior and disrespect for adults) as the need to build relatedness across students and teachers. This idea resulted in engaging students in a journaling experience about COVID-19.

During summer 2020, the Mountainview principal acquired funding to buy devices and mobile hotspots for all students in the school. Teachers had a new challenge: preparing for

teaching online, a significant task as they previously had not used many educational technologies in the school. After discussions with the principal about school needs, the principal and I presented a new (yet related) challenge to teachers: “How can we help students experience relatedness when they are learning online?” We explored this question through twelve one-hour workshops in June and July.

Three of the four teachers (Virginia, David, and Ana) chose to collaborate over the summer to address this challenge, and the school principal offered to pay the teachers an hourly wage for their participation. We began the summer workshops by talking more about the mindsets and how using them might give us different perspectives on creating relatedness online. The teachers explored various ways to interact with the problem space, including conducting phone interviews with students to better understand their experiences with remote learning. Over the final five workshop sessions, teachers prototyped activities that might support relatedness in the classroom. We completed each other’s activities and reflected on the results. Ultimately, teachers made plans for implementing some of the ideas once school began again.

Case Analysis

The analysis of the case data initially focused on the proposition that the design approach might support the development of both professional products and professional knowledge. Analysis focused on the outcomes reported by teachers in the post-interviews followed by a review of the workshop sessions in an effort to better understand how those outcomes came to be. In this section, I will present the analysis in a similar fashion. I begin with the outcomes reported by teachers—that our work helped them come to know and understand in new ways, deepen their understanding of students, and had a personal impact. Put together, these ideas illustrated something deeper than the development of professional knowledge suggested by the guiding proposition: the workshops supported sensemaking anchored in the particular context in which we worked. After exploring the outcomes, I will describe how these outcomes came to be from the perspective of hermeneutic design and sensemaking. Specifically, the sensemaking was

supported by epistemic diversity as well as the need to act on developing understandings through a design for learning.

Outcomes

During the post-interview, I asked teachers about their experiences in the workshops. In particular, I asked them to describe what we were doing, what was useful to them, what they learned, what they remembered most, and whether our work changed their own view of themselves or their practice. Table 5 summarizes their responses.

Table 5

Responses to Outcome-based Interview Questions

Interview Question	David	Virginia	Ana	Lisa
What were we doing in the workshops?	"Excavating relatedness through experimental design"; "trying something to find, to hit on relatedness, and then we try something else.	"Expanded our thought process," "have a specific thought about being" empathetic, analytic, creative, aesthetic	"Learning to control the emotion and behavior of kids"	"Collaborated and talked about how we can help our kids"
What was useful?	The idea of sketching and mindsets	Approaching from different angles	Build student-teacher relationship	Deep questioning; taking kids into consideration
What did you learn?	Relationships are active ingredient to their learning	Looking at things differently, "expanding the self-awareness and the knowledge"	Empathy, social/emotional learning, learn about the kids first	
What do you remember most?	The idea of fail-proof sketching	Technology tools	Activities in last weeks (Virginia and David's activities), four mindsets	Helping kids through a weird time, trying to see like the kids were seeing
Did our work together change your view of yourself or your practice?	"I have a different approach to authority as the teacher," Sees self as a learning leader, focused on showing, not telling	I need to be multi-dimensional with teaching	"My practice is the same but the strategies that changed"*	"Gave me a different idea of how to approach my kids, and how to get them more into like a critical thinking process,"

	Take student feelings into consideration

*In another place in the interview, Ana stated: “I never thought all this as a teacher, I go and . . . I am like a boss giving orders, that shouldn’t happen maybe.”

It is interesting to note that each teacher described the program differently. David focused on coming to understand relatedness, Virginia on using the mindsets, Ana on student behavior, and Lisa described collaborating to help students in general. The diversity of interpretations suggested teachers’ identities and individual needs affected how they experienced the PD program, akin to the effect of identity on personal sensemaking (Brown et al., 2008; Helms-Mills, 2003).

Although the teachers described their experiences in the program differently, synthesis across the embedded cases provided three general areas where all four teachers described positive outcomes: (a) teachers came to know and understand things in new ways; (b) they developed a deeper understanding of their students; and (c) they were impacted in a personal way.

First, all four teachers talked about *coming to know and understand in new ways*. For example, Lisa described the need to “interpret the ideas in our own minds,” while Virginia described “what you’re always having us do is keep asking more questions and folding it in and folding it in, just like this ripple thing and it helped me look at something more deeply.” Virginia described teachers as “a direction people . . . you do this and then expect this kind of result from it . . . we’re do it this way and I want to see this end result.” She contrasted this with our work together, where she could “do what [she] wanted” and “be creative about the activities” resulting in “expanding the self-awareness and the knowledge.”

Second, teachers came to a *deeper understanding of students*, including the value of focusing on student experiences. For example, Ana described finding value in talking about the “emotional level” from the students’ perspective. When she interviewed students in the summer,

Virginia was surprised that they liked talking to her and several thanked her for calling, causing her to think more carefully about students' experiences during the COVID-19 pandemic.

Third, each teacher described how *our work together impacted them in a personal way*. Lisa said in our work the teachers had to "involve ourselves in that moment of time." She described how the creative activities we participated in required considering her personal perspectives and experiences in relationship to what we were working on. Ana mentioned that through our work together she learned to "give out anything I have in my mind" instead of focusing only on what is right or wrong. Virginia reported our work helped her "become a better teacher and maybe even a better person." David described developing a different perspective on what it means to him to be a teacher.

Even though each teacher experienced the PD program differently, all described positive and personally significant outcomes. Teachers commonly connected personal experiences to our design focus and seemed to be working not just with professional practices and knowledge, but at a personal level. They were referring to the past to make sense of the present, while at the same time designing something for the future. They were engaged in sensemaking.

Supporting Sensemaking

The finding that teachers engaged in sensemaking begs the question: how did this sensemaking occur, and what features of the PD program supported sensemaking? Analysis of the data highlighted two ways the PD program supported sensemaking, the first through the use of epistemic diversity (mindsets) in the design of the program; and the second, through the framing moves required by design. Each element demonstrates how teachers both (re)interpreted past experiences and engaged in "creative authoring" (Brown et al., 2008) of the future. Each illustrates how both context and identity played a central role in sensemaking.

Making Sense through Epistemic Diversity

As described above, I encouraged epistemic diversity in the PD program through a variety of activities, scaffolded by a series of mindsets (see Table 4). These activities launched discussions about concepts and ideas related to teachers' concerns. This section presents how

epistemic diversity supported sensemaking by considering how teachers used each mindset to make sense of a core idea that became central to our explorations: relatedness. I will describe each mindset as well as present an example of how the teachers and I used the mindset in our design work. Then I will describe how I supported teachers to integrate the ideas to develop a richer understanding of relatedness.

Analytic Mindset. I used the term *analytic* to highlight normative scientific practices of developing propositional and correspondent-centered knowledge (Gobbo & Russo, 2020). This included both exploring academic research and theory as well as breaking down ideas into pieces (such as through mind maps) for further investigation. This section focuses on how academic theory and research helped us make sense of student engagement as situated during the COVID-19 pandemic.

In contrast to many PD programs, existing knowledge was not presented to teachers. Rather, I provided resources for teachers (white papers, practitioner articles, videos, etc.) and encouraged teachers to both review the resources as well as find their own resources. For example, after Workshop 5, I created a spreadsheet with literature on motivation as well as space for sharing summaries of each article. Lisa and Virginia each reviewed several articles.
In Workshop 6, Lisa shared her insights from a white paper on motivation and school reform (Usher & Kober, 2012). She immediately connected the literature to other conversations at the school, explaining that Mountainview faculty have “actually talked about that. We’ve talked about that a lot, about how we can make students more motivated to do their work.” Lisa drew our attention to four dimensions of motivation highlighted in the paper: competence, control/autonomy, interest/value, and relatedness. Usher and Kober described that relatedness means that:

> completing the task brings the student social rewards, such as a sense of belonging to a classroom or other desired social group or approval from a person of social importance to the student. (p. 2)

Lisa reported that relatedness “really caught” her, explaining “I have seen that before, like in my classroom if there’s a student that normally struggles and they see they’re understanding something or they answer something correctly . . . and everyone else in the class gets it, they kind of feel like they’re more with the class . . . I’ve seen it happen.” Lisa connected with the idea of relatedness because it helped her make sense of something she had seen in the classroom. It helped her (re)interpret her experiences in a way that made “the world more orderly” (Weick et al., 2005, p. 410). It was a concept Lisa found that she could connect with her own challenges (motivation in the classroom) and professional experiences.

Near the end of Workshop 6, we needed to decide whether to focus our design work on relatedness or another idea shared during the session—competency-based learning. In this case, the context guided us to choose to focus on relatedness. Lisa explained “I feel like right now with the kids working from home and us working from home, it’s going to be more of like a relatedness type of thing.” After continued discussion, David mentioned the difficulties of building relatedness through online learning, setting in motion the challenge that would be our focus several weeks later: how to build relatedness online.

Our analytic exploration of engagement and motivation, including reviewing relevant research literature, helped us understand how relatedness plays a role in student engagement. Relatedness supported understanding the past as well as provided a way for addressing our particular and very real challenge—engaging students in learning while physically separated. First, though, we needed to learn more about relatedness. As David wrote in a reflection after workshop 6, “In order to increase student relatedness, I will figure out what relatedness is and how I can improve it.”

Creative Mindset. As we continued to engage in making sense of student engagement and relatedness, we explored ideas from a creative perspective. The creative mindset focused on divergent thinking that could lead to new connections, creating new meaning. Creative activities included free writing, ideation, and various metaphorical explorations such as through art and movement.

Between workshops 6 and 7, teachers employed creative activities to further their understanding of relatedness. Lisa engaged in free writing about what relatedness means, leading to two new insights. First, in relationship to the context (COVID-19) and the current design project (the COVID-19 experience packet), she proposed that relatedness might include helping students connect their experiences with the experiences of others. She thought the teachers might be able to convey to students that "we've gone through things and we're okay, you guys are going through things right now, but you're gonna be OK." This idea came from thinking broadly about a concept and was actionable: Lisa suggested the teachers supplement the COVID-19 journal project with personal stories of challenges teachers had experienced and overcome.

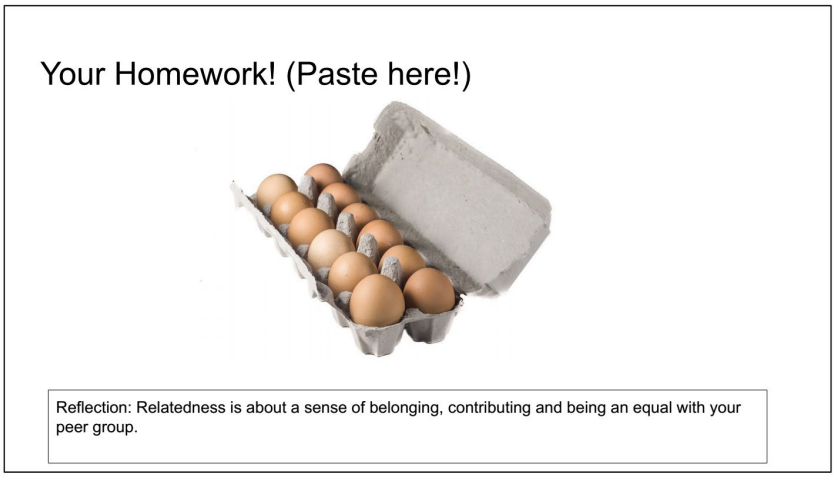
Lisa's second insight also drew on past experiences. She described a project the school had participated in earlier in the school year. A group of students created a model and plan for a "future city" concept of Mountainview as part of a national competition. Lisa noticed that at the presentation event, the students were proud of their work and of their city. They felt connected through their accomplishments.

Lisa's free writing about relatedness and accomplishment influenced our discussion of David's creative representation. David used a metaphor to enrich his understanding of relatedness. He found a picture of eggs in an egg carton and wrote "Relatedness is about a sense of belonging, contributing and being an equal with your peer group" (Figure 7). As we discussed David's metaphor, the potential meaning of relatedness expanded. Virginia asked whether the eggs were each unique ("individuals"), and David said they are, but they all have their own spot and part to play, and accomplishing something together, such as the future cities project, might build relatedness. In an attempt to better incorporate this idea—that each person has a unique part—David considered a puzzle metaphor, where each piece is important to the whole. These metaphors supported an expanded meaning from belonging to collaborating on a group project. At the conclusion of workshop 7, David wrote a new problem/solution statement in

his journal: “In order to create relatedness between our students, I will design an activity in which they can collaborate on.”

Figure 7

David’s Metaphor and Reflection on Relatedness



The expansive activities described in this section—free writing and metaphor—were embedded in personal experiences and context. The activities not only helped teachers see the past in a different way, but also suggested something to do to move relatedness forward: have students collaborate on projects.

Empathetic Mindset. While the analytic mindset explores a problem-solution space through empirical work and the creative mindset through divergence and redescription, empathetic work focuses on understanding others’ feelings, experiences, and emotions. Empathetic work, such as talking with students about their experiences, allowed teachers to step back and look at the situation from a new perspective, enabling them to find new ways of understanding student learning and engagement. Empathetic activities included asking students to write about their school experiences, and, our focus here, phone interviews with students conducted during the summer.

In June, the teachers decided that they wanted to learn more about students’ experiences with school during the COVID lockdown in April and May. They decided to each conduct several phone interviews, including calling students that struggled to complete work. In

addition to coming to understand the dynamics of doing school from home, the phone calls presented teachers with a puzzle: most of the students seemed to enjoy the phone call interviews, often thanking the teachers for calling and wanting to talk for an extended period of time. Ana explained, “They were happy when they got a call . . . they are excited to share their feelings.” We connected students’ positive reactions to the phone calls with an idea explored previously. In workshop 6, we had discussed how students *know* that they “are related.” Virginia had emphasized that students do not just need to be heard, they have to *know* that they are heard. She described this as a symbiotic relationship; there must be some reciprocal action to develop the feelings of relatedness. This idea helped us make sense of students’ positive reactions to talking with teachers—students wanted to be heard and needed to know that they are heard. They had been isolated from their peers and teachers, completing packets without receiving significant feedback, and were eager to reconnect with others.

The deeper understanding of the symbiotic nature of relatedness had implications for our future actions. In an online notes document, the teachers’ answers to the question “What might be an area we can explore more?” included “scheduled communications on a daily basis” and “interaction with students.” Exploring students’ experiences in the specific (and unique) context helped teachers better understand past engagement with remote learning as well as providing actions for future interventions.

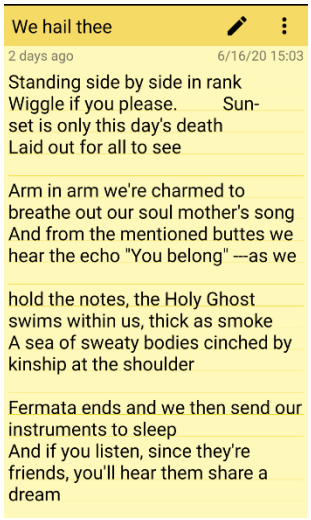
Aesthetic Mindset. I described the aesthetic mindset as coming to know through our own feelings and emotions. Learning through aesthetics required exploring personal feelings and experiences, often through artistic activities such as art or poetry. Root-Bernstein (2002) described that aesthetically-informed ideas and expressions (such as “elegant” scientific results or poetry)

> distill a huge amount of meaning in a very small space while simultaneously making a large number of connections to other results. The ability to concentrate meaning and connections maximizes understanding and its emotional impact . . . Only when we feel that we know and know what we feel do we truly understand. (p. 70)

Some activities grouped under the creative mindset might also be considered aesthetic, but where the creative mindset emphasized searching for the new, aesthetic activities explored personal emotions in depth. The clearest example of exploring relatedness through aesthetics comes from David. Between workshops 10 and 11, I suggested teachers choose an activity to complete from a list of potential activities from each mindset. David decided to explore feelings of relatedness through poetry (Figure 8).

Figure 8

David's Relatedness Poem



David's poem explored feeling relatedness during a college marching band rehearsal. He described how at the end of each rehearsal, the band would stand together and sing the school's alma mater. David's poetic language highlighted elements of relatedness that David understood in a very personal away. For example, he described "a sea of sweaty bodies cinched by kinship at the shoulder," which spurred a conversation about what it feels to be with a group after accomplishing something difficult together. Although a similar idea had been considered in Lisa's experiences with the future cities project, envisioning a "sea of sweaty bodies" added new weight to the emotional experience of belonging, concentrating meaning and offering new connections. As we discussed the poem, David mentioned that part of the power was also that they sang in

harmony, each individual having a part, connecting to the idea that relatedness can develop when everyone has an important part to play.

David's poem helped all of us come to understand relatedness in a deeper way. It offered insight into what relatedness feels like, something that we could strive to design for. It impacted the future through a powerful new question: "how can we help students feel this deep sense of relatedness?"

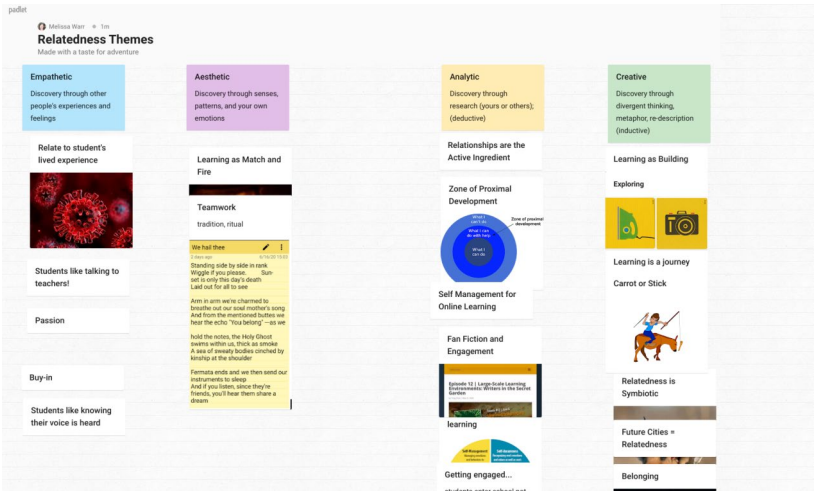
Integrating the Mindsets. The examples in this section demonstrate how epistemic diversity supported making connections across experiences, ideas, and emotions. What was perhaps most powerful in scaffolding our work around mindsets was not the individual insights that arose, but the potential for making connections across the different types of knowing we experienced. For example, David's poem highlighted what it felt like to work together and play an important role in a group, a concept originally discussed in relationship to Lisa's future cities experiences as well as David's egg carton. However, this type of integration did not always happen naturally. In this section, I describe an activity that helped teachers make more sense of both relatedness and the relationship across the mindsets.

Although individual understandings often suggested a way to move forward in the design—and often resulted in significant progress—I often felt that some of the richness we were discovering was lost before we were able to integrate it into a design. I hypothesized that part of the problem was that we did not have a good system for holding the new meanings together. Designers often make multiple sketches or representations of a design and use them together to move their work forward (Pendleton-Jullian & Brown, 2018). The original PD program had been centered on physical "sketchbooks" teachers could use to collect and document their understandings, but when we moved online, it was more difficult to keep flexible representations of our work. I attempted to remedy this through shared online note documents, but the static nature of the notes (pictures and words placed in an order) did not fully reflect the flexible epistemic diversity I had envisioned.

In planning for workshop 14, I decided to put representations of many of the ideas we had developed and explored on an online bulletin board (see Figure 9). I hypothesized that the board would support a more dynamic integration of ideas, where teachers could move representations of the ideas around freely and combine them in various groups, allowing a more explicit way to integrate across mindsets. I selected images, words, and resources from the shared notes doc as well as individual teacher reflections and placed them on the board. As a meta-cognitive act, we sorted the ideas by mindsets, discussing how each idea came about. We also added additional thoughts and ideas as we reflected on our work together. Then, we each selected a combination of elements and considered how we could incorporate the ideas into a design. The result was a visual sensemaking tool—it helped us piece together the understandings we had developed as well as consider how we would use the ideas in a design. We were going beyond interpretation, discovery, and understanding. We were moving forward to authoring and creation in an integrated way.

Figure 9

Online Bulletin Board for Integrating Mindsets



The combination of mindsets supported an exploration from various angles, which (in relationship to our relatedness focus) David described as:

> trying something to find, to hit on relatedness, and then we try something else. And we're like making all these cross sections and we're trying to put together the MRI that would reveal what relatedness is.

Virginia described the approach as something that "expanded our thought process," including "expanding the self-awareness and the knowledge" and supported looking at things differently. The epistemic diversity enabled a rich sensemaking process, where teachers' experiences and the particular context interacted to make sense of the past and design for the future.

In summary, epistemic diversity supported the PD outcomes teachers described: it helped them come to know in different ways, developed a deeper understanding of students, and allowed them to bring themselves—their emotions, experiences, and passions—into our work. Epistemic diversity helps explain the surprising outcomes that teachers each made sense of our work in different ways and that our work supported personal growth. Next, we look at another feature of the PD program that supported sensemaking: the design focus pushed our work forward, requiring choosing plausible explanations that would enable future action.

Making Sense through Imposing a Frame

A central piece of both design and sensemaking is a process of forward action and evolution, where designers (as sensemakers) impose some frame or plausible explanation, then gather more information to refine their understanding. The idea of acting in order to understand is similar to the model of design presented to teachers: acting on something, then reflecting on the results to learn and inform the next action (metaphorical "sketching," an idea that David called "liberating"). My original conceptualization of this idea hinged on concrete action: teachers would try something in their classrooms then refine the design based on the results. However, analysis of the case data highlighted a richer dynamic at play: even though the pandemic limited opportunities to apply designs, asking teachers to create *some* design that represented their understandings encouraged an intellectual act of imposing a frame and consequent revision. In other words, the need to act on their understandings pushed them to choose a direction and make sense of the situation from that direction. The frame was impacted by the particular context

teachers practiced in—a small, rural school trying to navigate the COVID-19 crisis—and a diverse group of teachers. “Solving” the problem was not about finding the right or best answer, it was about “articulat[ing] descriptions that energize” (Weick et al., 2005, p. 419) and allow enactment.

This section explores how the push to create something—even in an informal, casual manner—led to contextually relevant sensemaking. I focus specifically on Ana’s puzzlements over her experiences with students in the community. Ana immigrated to the United States from India and often struggled to understand the students in the local community. Although at first Ana struggled to impose a frame on her challenges, group discussions helped her explore options. Ultimately, the push to create an activity required choosing a frame. The original problem discussed in February—that students demonstrated disrespect towards adults—became reframed through a group discussion based on Ana’s activity. The new frame was actionable (and even energizing), providing a way to move forward.

Ana often shared stories of puzzlement over the behavior of students in Mountainview. As a new resident of the United States, she was attempting to understand and adapt to cultural changes. This was not a unique experience for Ana, as she had previously taught in both India and Oman. She explained she had “gone through many cultures of children.” There were several stories she repeated multiple times in our work together, suggesting they were significant events that she was trying to make sense of. Relevant to this analysis are two stories. First, on several occasions Ana described a conversation with a student in which the student talked negatively about the student’s mother, even telling Ana that she had “beat” her mother because she came to a sporting event the student didn’t want her at. Second, a student showed Ana a picture of a used car the student wanted to purchase, but the student did not have enough money to purchase the car. Ana found this puzzling because the student had a job and wondered why students did not save their money to make such purchases.

These two stories—a student describing “beating” her mother and the lack of saving practices—impacted Ana in the early workshops as we began discussing the challenges of the school. The original problem of students’ disrespect towards adults captured the first puzzlement.

The financial question arose in workshop 3, and at the time Virginia told Ana about Ruby Payne's (2005) writing on the poverty mindset.

During the final workshops of the program, Ana returned to her puzzlement over the challenges students had with saving money. In workshop 15, she retold the story about the student who wanted to buy a car. This return to an early idea—one not discussed since February—illustrated how passionate, and puzzled, Ana was over this issue. Ana initially considered addressing this problem through activities that centered on developing financial literacy. Virginia again drew our attention to the poverty mindset and suggested that perhaps the problem was deeper than financial literacy skills. Although I worried that a focus on the poverty mindset might perpetuate deficit views of the students, I chose to give the teachers space to explore their own ideas with the hope of shifting away from a deficit perspective in the future.

After workshop 15, Ana researched the poverty mindset. She came to workshop 16 with three potential frames for her design: in addition to inadequate financial literacy, the problem might be framed as students lacking ambition and/or students not appreciating what they do have (lack of gratitude). In the workshop, Ana's talk wavered back and forth between budgeting, goal setting, and gratitude.

Although at the conclusion of workshop 16 Ana did not know what to focus on, she came to workshop 17 with a direction. She told us, "I can focus at this time on gratitude." This decision was immediately actionable: she could create questions for students to answer in gratitude journals. The journaling activity provided a simple way to address the larger problem of the poverty mindset (itself a broader view on the lack of saving habits). She wanted the students to write about gratitude every day, so it becomes a "habit," hoping it would lead to a more positive mindset. The journal approach set a frame around the problem, supporting an interpretation anchored in the poverty mindset, gratitude, and positivity.

As we continued to discuss gratitude in workshop 17, David raised the idea of different feelings of gratitude, what Virginia later labelled "avenues of gratitude." David said we can be grateful *for things* or *to people*, and that being grateful to people might be more impactful for

students. The shift from gratitude for things (an avenue suggested by the original budgeting problem) to gratitude focused on relationships helped Ana make sense of the student who had reported beating her mother. Ana reinterpreted this as the student not being grateful for or valuing relationships. This interpretation enabled action: Ana could use a gratitude journal as well as other gratitude activities, such as supporting students in expressing gratitude, to help students understand the significance of relationships.

In workshop 19, we connected gratitude, relationships, relatedness, and student experiences during COVID-19 in a way that helped us make sense of the first problem identified by teachers in January: that students did not respect adults. First, Ana made the connection between the particular context (the COVID-19 pandemic), her personal experiences, and the gratitude activity. Several of the questions Ana had selected as journal prompts were focused on gratitude during the pandemic, something she felt was important for students to explore. Ana explained that the questions are “really my personal questions” that “came from my heart.” We compared Ana’s experience to student experiences during the pandemic. Then, I asked what the connection between gratitude and the student experience of COVID-19 meant for the gratitude journal. At this point in the conversation, many ideas came together that brought us back to the initial problem of respecting adults. First, Virginia described students’ “me mindset,” including that students don’t recognize how they affect others. She suggested they might “stretch those thoughts” through gratitude practice—and the results would have a ripple effect through the community, helping students become more productive citizens. I probed deeper into the connection between gratitude practice and impacting the community (being “far reaching”) and David explained, “I think it’s how they interact with the world. If they’re more grateful, they’ll have a better interaction with the people around them, the relationships will improve.”

David suggested supporting the interaction through encouraging students to express gratitude. Virginia connected David’s thought back to respecting adults: increasing the quality of interactions with others, including the teachers, might get students out of the “me mindset” and better understand how they are connected to others. This solution—journaling to encourage

gratitude awareness as well as positive interactions with adults—provided a new frame to our original problem. The problem shifted from a control or classroom management problem to a focus on relationships and experiencing positive interactions. The new problem frame centered on relatedness and interaction, not discipline. It was specific to the particular period of time, when physical separation required people to connect in new ways and when teachers needed to be more intentional about student interactions. It was actionable in relatively simple ways (daily journaling exercises and opportunities to express gratitude) and addressed both the original problem "disrespect towards adults" and the need to build relatedness.

The new frame came in a roundabout way—gratitude came through Ana's attempts to make sense of student budgeting practices as well as the way students treated their parents. Additionally, the need to design pushed us to make things actionable, leading to a frame that redefined the problem. If we had not been focused on something to do or make, we might have continued to explore the research around poverty mindset and financial literacy. However, needing to create something required Ana to impose a frame. It was not about finding the "right" explanation; rather it was about finding something that would enable action. This selection of a frame supported something that could be evaluated through personal experiences as well as future experimentation with students when school started again.

Discussion

In this article, I have described a case of a design-based professional development program planned and initiated previous to the COVID-19 pandemic but mostly conducted during it. In the case described here, both the teachers and I, the teacher educator and researcher, were engaged in constant adjustment to a rapidly shifting context with many surprises along the way. Of course, when I began this work, I did not expect to be conducting this research during a pandemic. The format of the program had to shift in response to the changing context. I also was surprised by the outcomes reported by teachers. Although I hoped design might have some impact on teachers' professional identities, I did not anticipate the impact personal identity and past experiences would have on our work, and I did not envision our design work as

sensemaking. These surprises highlight the power of a design approach to teacher education: it provides a way of working and learning that is responsive to complexity and that integrates personal and professional experiences, beliefs, and emotions in a future-oriented way.

In this section, I return to the concepts laid out in the theoretical framework section and expand on them based on the findings of the case study. First, I argue that epistemic diversity and the framing moves that undergird design support sensemaking and that the process of design could be interpreted as a type of sensemaking. Second, I describe a key feature of design that makes it effective in complexity: design is about responding to back-talk from the situation, and that situation is expected to change. Third, I provide a designerly perspective on reflection to demonstrate how design work might be an effective pedagogical approach for integrating personal and professional identity and context in a flexible and actionable way.

The Role of Epistemic Diversity and Frame Setting in Sensemaking

The case described here highlighted two core features of the PD program. First, epistemic diversity encouraged taking new perspectives on a situation, such as how David's egg carton representation of relatedness suggested feeling equal with a peer group. Second, the need to design something pushed teachers to select actionable ways of framing the situation; I highlighted how Ana selected a gratitude frame to understand and act upon her puzzlement about student behavior. Both epistemic diversity and frame setting helped teachers make sense of the past, present, and future; they supported sensemaking. Weick (1995) described sensemaking as a combination of discovery and creation. In this case, *discovery was supported by epistemic diversity and creation through acts of framing.*

First, epistemic diversity made space for discovering new ways of seeing things. The resulting sensemaking was impacted by each teacher's personal and professional identity, resulting in different interpretations of our work together. For example, reading scholarly literature introduced Lisa to the idea of relatedness. She used this idea to make sense of past classroom experiences. In a poem about a time he felt relatedness, David described a marching band rehearsal where each band member had a part to play. Reframing his personal experience, and,

importantly, the feelings he felt in that experience, as relatedness helped him make sense of his experience as well as the concept of relatedness in a new way.

Sensemaking includes not just a reconsideration of the past but also involves acts of creation. This was seen in how the teachers were able to place an actionable frame on a concept to move it forward to action. For instance, consider Ana's move to address student savings habits and poverty mindset through gratitude journaling. David brought relatedness into the conversation by emphasizing the need to be grateful to people, and a group discussion about these ideas led to linking gratitude with connecting to and respecting others, both peers and adults. A gratitude frame offered a simple and straightforward way for Ana to make sense and act on her experiences. The gratitude frame also provided a new way for the teachers to see and address the problem of practice selected at the beginning of the program.

Design as a Type of Sensemaking

Sensemaking was not the original framework I used as I began this research. However, the tumultuous nature of the implementation time frame meant our work together was particularly useful as a space for processing the events around us as well as considering what the context means for schooling. The result was an emphasis less on the implementation of new approaches and more on the mental act of seeing both the current context and past experiences in new and actionable ways. Our experiences highlighted the sensemaking dimension of design.

The idea of design as a way to make sense is not new. For example, Krippendorff (2005) wrote that "Design is making sense of things," and that "design is a sense-creating activity" (p. xv). Thus, design could be considered a *type* of sensemaking; it is a particular way to make sense of the past, present, and future. What differentiates designerly sensemaking from other types of sensemaking is the intentionality in creating the future. Krippendorff (2005) stated that "designs' proposals about the future amount to constructive interventions. If a design would become real without intervention, it wouldn't be a design" (p. 30). Sensemaking, as described by Weick (1995), is about creation and authoring, but that creation and authoring is often suggested

as a direct result of seeing the past and present differently rather than acting to change the future. Design, however, focuses specifically on creating interventions to shape the future.

Because design combines (re)interpreting the past and changing the future in a dynamic way, it is particularly adept at working amidst complex situations. A designerly way of working is effective in complexity because it recognizes complexity as being integral to its scope of work and *responds* to it. This is what Donald Schön (1992) means when he talks about having a "conversation with a situation" (p. 125). In a verbal conversation, an individual talks to others not because they know what the other is going to say, but to find out what the other will say. Each turn in the conversation influences the trajectory of the conversation, and the resulting dialogue is a collaborative construction of the participants' interactions. Similarly, having a conversation with the situation means both the designer and the situation continually change in response to each other. Schön (1983) explained, "The unique and uncertain situation comes to be understood through the attempt to change it, and changed through the attempt to understand it" (p. 132). Because design is a perpetual conversation, it naturally adapts to a shifting context, even when the shifts go far beyond changes the designer implements.

In the case described here, design work had to respond to an uncertain and complex context: the early stages of the COVID-19 pandemic and its effects on schooling. For example, what student behavior and engagement looked like on March 10, 2020 was drastically different from what it looked like after the school closed on March 15, 2020. Design supported this rapid change: if a designer is having a conversation with the situation, the situation is free to change; the designer simply continues to respond to it. This is what makes design effective in complexity: it supports changing with what happens rather than only in response to what has happened in the past.

In this case, changes in the situation pushed us to reframe our focus from student behavior to relatedness. The focus on student behavior did not go away; it was reframed because of how the context changed. Relatedness was connected to student behavior; in fact, at the end of the program, the teachers created a direct link from student behavior and respect for adults to

relatedness and gratitude. But considering the situation as a need to build relatedness was a way to respond to the broader context, making the challenge more relevant to what teachers were experiencing in the present and would experience in the future. It provided an actionable way to make sense of their current and future experiences.

Design, Sensemaking, and Reflection-in-Action

Designerly sensemaking is mediated by reflection. In fact, Schön described design as being a type of reflection. This is particularly true when the situation changes, as it has with COVID-19. Previous experiences now hold new meaning and require a different way of considering the situation, one that reaches beyond personal actions and beliefs. It requires not just a conversation with the self, but a conversation with the shifting situation in relationship to the broader context. This is what Schön means by design as "reflection-in-action:" it is reflecting on the situation during a time when the active reflection can still influence the situation. Schön's reflection-in-action is not only (or even mostly) focused on personal beliefs or actions. Rather, the object of the reflection is the situation, a situation that can (and, in fact, will) change throughout the design process.

This does not mean that reflection-in-action neglects the personal development of teachers. As seen in this case study, reflecting on the situation from various epistemic perspectives brought in teachers' personal experiences and beliefs even though our work was not focused specifically on them. As in Jahnke's (2012) critical hermeneutics, the reflection not only impacted the design situation, but led teachers to see things (and their students) differently. Ultimately, teachers experienced shifts in personal beliefs and identity. Choosing a frame and acting on it helped teachers bring their new understandings into their practice. The result was an ongoing process of designerly sensemaking that responded to complexity and supported teachers in integrating their professional and personal identities within this dynamic context.

Moving Forward with Teachers and Design

The particular case explored in this paper offered insight into the relationships among reflection, design, critical hermeneutics, and sensemaking. Epistemic diversity and frame setting

supported teachers in bringing themselves into the design context, integrating their identities, professional practices, and the shifting context in a meaningful way that not only helped them make sense of the past, but also shape the future. The case is reminiscent of Jahnke's (2012) writing about the emancipatory power of design:

> The design, or the poem, or the "other" is . . . something that is "thrown into the world" as a proposal to be interpreted, and thus it holds the capacity to open up new worlds. If we then combine the poetic reference and the ability to rewrite reality with a critical perspective, we gain a subversive mode of the possible, or better, of the power-to-be. (p. 35)

When teachers become designers, they begin seeing new ways to make sense of the past and shape the future. Their reflection becomes an act of interpretation, and, through designerly sensemaking, they change themselves *and* the future.

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CHAPTER 4

"SEEING THINGS DIFFERENTLY": TEACHERS, DESIGN, AND INDETERMINACY

Interlude

In chapter 3, I described a case of a design-based professional development program, including how the program supported teachers in productive sensemaking through epistemic diversity and frame setting. As part of exploring how teachers were able to develop personally meaningful interpretations of our work, I considered the idea of indeterminacy, that there can be many different interpretations of a situation, each that can result in different outcomes.

In this final article, I synthesize what I learned from the case study data as well as the design literature to argue that what is unique about being a designer (as opposed to someone who makes things) is their ability to see, and even embrace, indeterminacy.

Introduction

Design is a process of acting on the world, or as Herb Simon (1969) described, of "devising courses of action aimed at changing existing situations into preferred ones" (p. 111). Simon offered an outside-in view of the process of design, where the inner world of the designer meets the outer world of the evolving design. There is another perspective on design, however, one that recognizes that the act of design changes not just the outside world but the designer themselves, and that design can be a form of personal interpretation and sensemaking.

Like designers, teachers take an existing situation (for example, their students' current knowledge or understanding) and devise ways of moving it to something more preferred (a change in knowledge or understanding). This has led some to claim that teachers are designers (e.g., Carlgren, 1999; Goodyear, 2015; McKenney et al., 2015). I recently analyzed literature on teachers and design in an attempt to better understand the relationship between these concepts. I started with this question: "What does it mean for a teacher to be described as a designer, or for the act of teaching to be considered an act of design?" I found the academic literature described that when teachers designed, they not only created new professional products (such as worksheets, lesson plans, or curricular units), but also developed professional knowledge.

Although the current literature on teachers and design is valuable for understanding the professional activities of teachers (an outside-in view), it provides less insight into the internal and personal aspects of design. Additionally, the literature presents the context teachers design in as mostly stable, rather than the constantly shifting social and political environments teachers work in today. Paying more attention to the internal dynamics of design, as well as the role that context plays in teachers' design work, could provide useful directions for teacher education. Indeed, many teacher education scholars have emphasized the need to consider the personal beliefs and identities of teachers as well as situate teaching in the social context (e.g., Beijaard & Meijer, 2017; Clarke & Hollingsworth, 2002; Korthagen, 2017) For example, Korthagen described:

> If we wish to promote teacher learning, we will have to take their thinking, feeling and wanting into account. Moreover, these dimensions are always influenced by the social context, which means that attempts at influencing teacher behaviour have to be adjusted to individual teachers in their specific circumstances and settings, and that it is impossible to promote change through a pre-planned, fixed curriculum. In other words, we need a shift in focus from the curriculum to the learner. (p. 391)

The literature on design suggests that design is not just about creating external products or professional knowledge; it is also deeply personal and context laden. For example, Jahnke (2011, 2012) compared design to critical hermeneutics, claiming that design is a personal and context-bound meaning making process. Bringing this type of design to the teaching profession requires a different perspective on teachers and design, one that focuses on what it means for teachers to think and act as designers. It moves beyond design*ing* to being a design*er*. At some level this may appear to be a trivial or even meaningless distinction, but while designing focuses on the process of the work and the object being created, becoming a designer connects with identity and draws attention to the personal nature of one's work. The former is an "outside looking in" perspective about professional activities as opposed to the "inside looking out," a more personally centered way of approaching the work of teaching.

I came to see the inside looking out perspective on teachers as designers through my attempts to support four teachers in design work. I created a professional development (PD) program where teachers would choose a problem-of-practice salient to them and we would work together to interact with the problem in a designerly way. I collected data (pre- and post-interviews, videos of sessions, artifacts, and research memos) throughout the workshops as part of a research study. Like much research (and life) in 2020, the COVID-19 pandemic disrupted the teachers' and my plans, forcing us to regroup and move our work online. Instead of focusing on creating external products for or implementing actions to interact with problems-of-practice, we were pushed to focus on internal design processes through exploring ideas and making sense of the rapidly changing context. I experienced unexpected challenges and observed unexpected outcomes of our design work. The result highlighted an aspect of design that I wouldn't have noticed otherwise, what I believe differentiates a designer from someone engaging in design tasks: designers see, and even embrace, *indeterminacy*.

In this paper, I argue that a central characteristic of designers—the difference between engaging in design tasks and being a designer—is the relationship designers have with indeterminacy, including their ability to lean into, and maybe even capitalize, on it. An indeterminate perspective makes space for the integration of personal beliefs, identity, and experiences with a design. I develop this argument by first defining indeterminacy and explaining the relationship between indeterminacy and design. A brief diversion into a related theoretical construct, Donald Schön's (1983) reflection-in-action, provides insight into how designers work *with* indeterminacy. After laying out the core constructs, I dig deeper into the role of indeterminacy in the PD program, highlighting the participating teachers' struggles of seeing and working with indeterminacy as well as the power from learning to do so. Finally, I use the work of design scholar Jahnke (2011, 2012) to illustrate how design and indeterminacy helped the teachers create and act on personal interpretations of the design situation as situated in the broader context of a global pandemic.

Indeterminacy

Indeterminacy describes situations where there are many different approaches or ways to work with something. Buchanan (1992) contrasted this with un- or under-determinacy, where the goal is to understand or find out more about what is already there. For example, scientific thinking focuses on describing concepts and relationships that already exist and so operates in the under-determinate sphere. Underlying under-determinacy is an assumption that there *is* a solution waiting to be found and the only thing holding us back is a lack of information. Indeterminacy, on the other hand, is a recognition that there is no single solution to a problem. Designers work from an assumption of indeterminacy. They see design as a process of creating one of many possible futures (see Krippendorff, 2005), not necessarily finding the right solution. This does not mean that designers are not interested in data or information, but rather that they recognize that there never will be complete information and that our acts of design will have consequences that we cannot predict. Furthermore, even the outcomes of designs can be interpreted in various ways, continuing the indeterminacy cycle.

Consider the challenging situation of the COVID-19 pandemic. As I write this, several vaccines have been deemed effective and the governments are racing to vaccinate as many people as possible. A year ago, a vaccine did not exist. There were many possible approaches for creating a vaccine, as evidenced by the multiple vaccines created. The creation of a vaccine was indeterminate. However, last summer scientists were experimenting to identify the efficacy of their specific vaccine. They were trying to understand the properties of what they had created. The well-defined problem—evaluating how well a specific vaccine prevented symptomatic COVID-19—was under-determined.

Of course, the focus on creating a vaccine itself was a choice in response to the indeterminacy of the COVID-19 situation. A vaccine was just one way to address the situation. Creating a vaccine was the result of several choices already made: we had decided that we needed to make people immune to the virus and that a vaccine was the way to do so. Other approaches were possible: for example, Sweden attempted to create immunity through natural

means (Claeson & Hanson, 2021). New Zealand went a different direction, practically eliminating the virus from their country without herd immunity (Bremmer, 2021). Another option might be to simply learn to live with the virus, perhaps reorganizing social structures to protect vulnerable individuals. The point is that while finding the effectiveness of a single vaccine is under-determinate, the decision to deal with the virus through building immunity, to use a vaccine to develop immunity, and the creation of the vaccine itself was indeterminate. A vaccine was created through interpreting the situation in a certain way and acting accordingly.

Because indeterminate situations can be interpreted in different ways, there is no given subject matter; the designer chooses (or in a way, creates) one of many possible approaches. Something that is indeterminate is “waiting to be made specific and concrete” (p. 17), and there are multiple ways of doing so. Buchanan (1992) described:

> Design problems are “indeterminate” and “wicked” because design has no special subject matter of its own apart from what a designer conceives it to be. The subject matter of design is potentially universal in scope, because design thinking may be applied to any area of human experience. But in the process of application, the designer must discover or invent a particular subject out of the problems and issues of specific circumstances. (p. 16)

In other words, designers do not just make things. They discover—or invent—new subject matter out of the situation. They develop their own interpretations of the situation.

Because indeterminacy means there are many possible interpretations of a situation, designers must make choices—choices driven by data but also by expertise and experience. These choices are often represented as design moves, preliminary “sketches” that allow them to see and understand how the situation responds. A sketch represents a “frame” for the problem—an externally imposed structure that can then be evaluated. Since it is externally imposed, the frame is not necessarily emergent from the task at hand but rather is brought into play by the designer based on their experience, their prior engagement with similar (though rarely, if ever, identical) design tasks. The frame may offer some opportunities and possibilities to explore but

may also lead to dead ends. Either way, the frame helps the designer develop a deeper understanding of the contours of the task at hand. This new understanding can be used to repeat the process, moving the design forward.

What is important to understand is that the imposition of a frame is a critical move in taming the complexity (the indeterminacy) of the situation. Imposing a frame on a situation and interpreting the results is at the heart of what Donald Schön called reflection-in-action, a "generic design process" (p. 77) that underlies all design work, regardless of the type of design being engaged in. Reflection-in-action—including a type of reflection-in-action called a "conversation with the situation"—is how designers manage indeterminacy. Core to reflection-in-action is a pattern Schön and Wiggins (1992) described as how a designer "sees, moves, then sees again" (p. 135), resulting in "having a conversation with the materials of a situation."

Reflection-in-Action: See-Move-See

> A designer sees, moves and sees again . . . the designer sees what is 'there' in some representation of a site, draws in relation to it, and sees what has been drawn, thereby informing further designing. (Schön & Wiggins, 1992, p. 135)

Reflection is not a new concept in teacher education or teacher professional development, however the type of reflection I describe here differs from how reflection is often conceptualized in teacher education. Rather than the object of a reflection being a personal experience or belief, in reflection-in-action, the object of reflection is the materials of the situation as they are framed by the designer. Sometimes the materials of the situation respond in unexpected ways, opening possibilities for other moves. Schön (1992) called this "having a conversation with the situation" (p. 125).

Having a conversation with the situation means both the designer and the situation are interacting to produce something new, similar to how people create a shared understanding through talking with one another. In constructive conversations, individuals do not speak knowing what the other will say. Rather, they say something to *find out* what the other will say, which then

impacts their next turn. The result is a conversation constructed between two or more individuals, each playing a significant role in shaping the conversation.

What, then, is this situation that one can have a conversation with? Clara (2013) described a situation as “a system of actants in interaction that is experienced by the subject as a unique and inseparable *whole*” (p. 119, emphasis in original). “Actants” implies that elements of a situation have agency; they respond (“talk back”) to actions or frames imposed on them. The designer experiences this backtalk in a holistic way. Thus, in a conversation with the situation, a designer speaks to the situation by making a move (placing a frame on the situation) and listening for unexpected outcomes.

Schön (1983) provided an example of reflection-in-action through an analysis of a conversation between an architecture student, Petra, and her professor, Quist. In the process of designing a school building, Petra was struggling with adapting the building to the slope of the site. Quist suggested that instead of focusing on the slope, to “impose a discipline” (what I am calling a frame) on the situation by seeing each classroom as a certain 2-dimensional (2D) shape (here, they selected an el-shape), and then attempt to place the 2D shape on the 3-dimensional (3D) slope. Quist perceived the backtalk from this approach: to put the 2D classrooms onto the 3D shape, there would need to be a combination of retaining walls and stairs or ramps to resolve the shifts in levels. He proposed each classroom be placed on its own level. After making this move, Quist sees something unexpected: the differences in levels overlapped in a way that could create 5 feet tall “nooks,” unique spaces for students to occupy. By imposing a frame on the situation then reflecting on what the frame meant for the situation, Quist was able to see something unexpected in the design, offering a new idea to move forward with. He hypothetically changed the situation, the situation talked back, and he again revised the situation. He engaged in see, move, see.

Reflection-in-action is a type of inquiry or probe. The inquiry is found through seeing a different way of interpreting and interacting with the situation. The inquiry is put on the situation,

and the conversation moves forward in a fluid and even “ephemeral” (Schön, 1992, p. 125) manner. Schön (1983) described:

> When someone reflects-in-action, he [sic] becomes a researcher in the practice context. He is not dependent on the categories of established theory and technique, but *constructs a new theory of the unique case* [emphasis added]. His inquiry is not limited to a deliberation about means which depends on a prior agreement about ends. He does not keep means and ends separate, but defines them interactively as he frames a problematic situation. He does not separate thinking from doing, ratiocinating his way to a decision which he must later convert to action. Because his experimenting is a kind of action, implementation is built into his inquiry. (p. 68)

In other words, reflection-in-action is integrated with implementation because it is a reflection on the situation; it is perceiving what happens when a certain interpretation is imposed on the situation and responding accordingly.

The connection between reflection-in-action and implementation has led many to define reflection-in-action as a rapidly occurring act of improvisation. Schön often described reflection-in-action in this way. However, Schön (1983) explicitly refuted the idea that reflection-in-action always occurs quickly. He wrote:

> A practitioner’s reflection-in-action may not be very rapid. It is bounded by “action-present,” the zone of time in which action can still make a difference to the situation. The action present may stretch over minutes, hours, days, or even weeks or months. (p. 62)

Reflection-in-action is something that occurs when “action can still make a difference to the situation,” such as when Quist was taking actions that could affect the school design. When considering the “situation” as a single lesson, reflection-in-action might happen rapidly during the lesson, as teachers adapt to student responses. However, if the situation is a unit, a semester, or something of unknown length (such as the COVID-19 pandemic), changes can be made across a longer time frame in a less rapid way. The core idea of reflection-in-action is not the time frame it occurs in; it is in the object of the reflection, probe, or inquiry: the situation as framed by the

designer. Reflection-in-action can only occur when the situation can respond to the frame placed on it.

Understanding the active situation as the object of reflection is critical to understanding design because design is a combination of learning about and changing something. These two activities, learning and changing, work in tandem. Schön (1983) explained: “The unique and uncertain situation comes to be understood through the attempt to change it, and changed through the attempt to understand it.” (p. 132). In order to reflect-in-action, the situation must be able to be changed, and new interpretations come through making these changes and perceiving the results.

Seeing Indeterminacy

Engaging in reflection-in-action requires the designer to “see” something that then enables a move; they must find a frame to impose on the situation. However, in any given context, there are multiple ways of seeing the situation, each with potential to change the moves the designer makes and the backtalk they receive. For example, Quist chose to impose 2D el-shaped classrooms on the slope, but he could have selected other shapes or taken a different approach altogether. The problem space was indeterminate. Quist dealt with this indeterminacy by imposing a frame and responding to the results.

Although we all live amidst indeterminacy, where the things around us can be interpreted and interacted with in many different ways, designers *see* indeterminacy and make it part of how they work. They question what is often taken for granted, opening space for new interpretations. These new interpretations lead to different ways of interacting with the world.

The idea of seeing indeterminacy became salient to me as I attempted to help teachers design activities to address specific goals. I began working with the teachers in January 2020. A core piece of my theory about how to help teachers design was centered on encouraging them to implement new ideas in their classrooms (make a move) then consider the results (reflect on the backtalk) and revise accordingly. I was focused on the external activities of design; I was attempting to support the teachers in designing. The teachers identified a challenge to explore:

they felt their students did not show appropriate respect towards adults. We began investigating this situation through both reviewing research literature and exploring students' perspectives. Just as the teachers were preparing to make a move by testing new ideas in their classrooms, the school closed due to the COVID-19 pandemic. Our ability to focus on the professional design activities of teachers—what teachers created and implemented in their practice—was severely limited.

We continued our work together online, discussing the challenges the teachers were having with connecting with students and motivating them to complete the packets of work that teachers sent to them. One teacher came across the idea of "relatedness," and we refocused our efforts on how we might support relatedness in the upcoming school year. In particular, the school was acquiring devices for the students so school could be held online the following school year, and the teachers puzzled over how they might support relatedness in online learning. However, although we continued to explore these ideas, we were limited in our ability to implement ideas with students, as the school had not yet distributed devices to students.

At the time, I believed that this inability to make a concrete move was limiting our ability to design. During July 2020, I attempted to remedy this by asking the teachers to design a brief online activity we could complete amongst ourselves. I created an example which we all participated in, then modeled a reflective conversation focused on understanding how we each experienced the activity. We then discussed what surprises resulted from the activity as well as what changes I might make to the activity to better meet my goals. I made the changes, and we again participated in and reflected on the revised activity.

It was only when I asked the teachers to design activities themselves that I began to understand the difficulties they had in seeing indeterminacy. Two of the teachers created writing assignments consisting of a list of prompts for students to respond to. The prompts were well thought out and interesting to engage with. However, after some reflection on our experiences completing the prompts, I asked the teachers what they might change to adapt the activities to better meet specific goals. At first, they struggled to describe any changes. Eventually, they

focused on changing the content of the prompts themselves and, even with some urging, struggled to see other possibilities (for example, changing activity structures such as whether students completed the work independently, in pairs, in groups, etc.). The writing assignments were built on an interpretation of learning as personal development that could be promoted through independently answering specific questions. Other interpretations—such as seeing learning as forming connections across people and ideas—would have suggested other design choices, but the teachers struggled to see these other choices.

Later, when reviewing the data, I realized that my question of *what* the teachers could change to make the activities better meet their goals assumed that they knew which pieces of the activities they *could* change. They needed to be able to see the indeterminacy in their designs. They needed to recognize that they were interpreting the situation in just one of many possible ways, which led them to make certain design choices. Other interpretations—and the corresponding design choices—could have also been made, offering new possibilities (in fact, as I will later describe, at the end of our work they did come to interpret the situation differently). On the outside, teachers were participating in a design task—they were designing an activity. However, internally, they were not viewing their work as a designer would; they were not seeing and evaluating various choices they might make to reinterpret the situation and improve the design.

Helping teachers see the indeterminacy in a design might be an effective first step in moving them towards being a designer. However, simply seeing the indeterminacy is not enough. Designers must have some way to move forward in the indeterminacy. To do so, they choose one of many possible approaches (see), apply it to the situation (move), and then evaluate the consequences (see again). It is to this process of making a move (placing a frame on the problem) then perceiving the consequences that I turn to next.

Moving and Seeing Differently

> The design process opens up possibilities for surprise that can trigger new ways of seeing things, and it demands visible commitments to choices that can be interrogated to reveal underlying values, assumptions, and models of phenomena. (Schön, 1992, p. 131)

Once designers see something that might be changed or reframed in the situation, they must make a move, consider the consequences, and then use what they learn to continue with the design process. This move may be made through a mental act of seeing the situation from a different perspective or a more direct approach of directly acting on the situation. For example, Quist made a move when he chose a frame of seeing the classrooms as 2D el-shapes. Then, through talking aloud and drawing, worked through how the frame would interact with the 3D slope. In some disciplines, moves might also be implemented in the situation as it plays out, such as a teacher asking a question to find out how students are understanding a concept. In both cases, the practitioners make a move that helps them learn more about how the situation they are working with will respond. The response can then inform future moves.

This process of making a move to find out implications is common across many types of thinking. For example, scientists might make a hypothesis then conduct an experiment to determine whether to reject the hypothesis. Designers, however, act in indeterminacy: they choose one of many possible ways of acting. In fact, they might not even have a clear reason as to why they choose the move they select to act on. Quist told Petra to “begin with a discipline, even if it is arbitrary” (Schön, 1983, p. 85). The action is taken to see what happens and to learn more about the situation, not necessarily because the designer thinks it will work. It is a probe, an experiment that is intended to allow the agency of the object being designed to reveal itself.

Furthermore, designers perceive the result of their moves in an indeterminate manner. Once a move is taken, the designer must then hear how the situation talks back. However, although the actants of a situation respond independently of the designer, the designer can perceive and interpret the backtalk in different ways; the backtalk becomes indeterminate through the designer. In other words, the way the designer interprets the backtalk makes it indeterminate,

producing more possibilities for their next turn in the conversation. This means designers see indeterminacy in two ways: they see indeterminate options for moves they might make and then consider various interpretations and surprises in how the situation responds to the moves they make.

The significance—and challenge—of perceiving the backtalk in an indeterminate way became apparent to me as I attempted to help teachers lead conversations around each other's experiences with their designed activities. After we had each created a short activity and completed each other's activities, I asked teachers to lead reflective conversations about their activities. I hoped the conversations would help us interpret the results of the activities (the backtalk from the situation) in a productive manner. However, I found the teachers struggled to work in this way.

For example, when I asked one teacher (whom we'll call Virginia) to lead a discussion about her activity, she seemed at a loss as to what to do and what kinds of questions to ask. I was puzzled at why this was difficult; she had been a significant participant in two similar discussions I had modeled, coming up with unique and interesting ideas to share with the group. Eventually, I suggested she ask us about our experiences with the activity. In the ensuing discussion, one teacher described discomfort when they saw a question that felt irrelevant to them. The result was a negative experience for this teacher. I felt we had found an unexpected outcome of the activity that Virginia could consider through a redesign of the activity.

At the conclusion of our discussion about Virginia's activity, I asked Virginia what she learned. She replied that she needed to give her students a platform to explore their ideas. I did not see the connection between our discussion and this response. I redirected:

Researcher: Is there anything you would *change* in the activity?

Virginia: [in a puzzled tone:] Change? [in a quick, assured tone and with a big smile:] Make you answer all the questions.

[laughter]

Researcher: If you had to revise this, and give us something to do by Friday, what would you change?

[laughter]

Researcher: Make us answer all the questions?

Virginia nods. [laughter]

Researcher: Is there anything you're still curious about?

Virginia: umm, hmm. I need to think about that one.

Here, Virginia changed an uncomfortable situation—one where she didn't know how to respond—into a joke. We had just discussed how it was important to let people choose which questions to answer, so the response to "make you answer all the questions" was provided in jest.

This example illustrates the difficulty in seeing the indeterminacy of the design choices, as described earlier in this paper—Virginia did not see what she *could* change in the activity. However, I believe it also illustrates a challenge with the indeterminate perception of the backtalk. Virginia did not know what to ask about her activity because she did not come with a mindset that it could produce different experiences from what was expected. To illustrate this point, consider this excerpt from an interview I later conducted with Virginia:

Researcher: What's the most important thing you learned doing these workshops that we've done?

Virginia: Um, probably the, I don't even know if it's a good term but like the divergent thinking and I've said that before, too . . . being able to look at things differently. I think that's what I appreciate about it.

Researcher: Can you give me an example of when we looked at something differently?

Virginia: Hmm. So when we went through activities and being able to analyze not only why we did the activity, but what that activity produced. Specifically, when we are talking about, I think Ana was talking about the gratitude journals and having the students be aware of what they're grateful for, doing her journal helped analyze those things within

> myself . . . it's always good to be able to say, Oh, I never thought about it that way before, or I never thought about *that* before.

I will discuss Virginia's experience with Ana's gratitude journal in the next section. For now, consider how Virginia was describing coming to see the backtalk of the situation as indeterminate. She commented that she appreciated "being able to look at things differently," and connected that with "not only why we did the activity, but what that activity produced." She was learning to see different ways of understanding the outcomes of the activity, outcomes that might be different from "why we did the activity." She was learning to perceive the backtalk differently.

"Seeing things differently" is at the heart of seeing indeterminacy—that there are different ways to perceive, experience, interpret, and act upon something. It is how designers create unique designs that fit in complex contexts. But it also highlights a different aspect of this inside-out perspective on design. The indeterminacy of the situation, including the indeterminate ways designers perceive the backtalk, means individuals can experience a situation in many different ways, ways that are unique to them. Design becomes not only about changing the situation, but also changing the designers themselves. This aspect suggests that we ought to go beyond reflection-in-action, to a more critical hermeneutic stance that better accounts for the personal meaning making aspects of design.

From Reflection-in-Action to Critical Hermeneutics

A complete analysis of my work with the teachers revealed that teachers described that one of the most significant outcomes of the PD program was personal change. In other words, in the process of changing the situation, the teachers themselves experienced change. Moreover, the broader context of the study—what might be considered outside the scope of the situation that could be directly acted on—changed in significant and unexpected ways. The complexity and shifting nature of the broader context (teaching in a rural school during a pandemic) had a significant influence on our work, beyond the backtalk from the immediate design situation. This, I would argue suggests moving away from reflection-in-action to a position more consistent with Jahnke's (2011, 2012) writing on design as critical hermeneutics.

Jahnke (2011, 2012) highlighted several limitations of Schön's reflection-in-action such as the "inert self" of the designer and the artificial separation between subject and object, including lack of recognition of the dynamic relationship between the subject, object, and the larger world context. To address these limitations, Jahnke argued for a critical hermeneutic perspective where the designer is changed in the design process. Design could be thought of as an act of interpretation, where "all problem solving occur[s] *within* [emphasis added] a process of seeking an evolving meaning" (Jahnke, 2012, p. 39). Design becomes an act of sensemaking, where the designer tries out different ways to interpret (make meaning of) a situation and considers the results of that interpretation. Importantly, this meaning making occurs through the integration of the self and global context.

Design supports personal meaning making *because* it operates in indeterminacy. Because there are many ways to frame a situation, designers select a frame that unavoidably reflects their own beliefs, identity, and experiences. As the designer interacts with the situation, including interpreting the backtalk, they develop new ways of seeing things, perspectives that are, at least to some extent, unique to them.

Let's return to Ana's gratitude activity. Ana's decision to create an activity around gratitude came from a larger issue she was concerned about: she had witnessed students struggling to save money. Although Ana originally considered addressing this situation through lessons on financial literacy, Virginia suggested the challenge might be deeper than that; it might have to do with the "poverty mindset" (see Payne, 2005) of many of their students. Ana researched the poverty mindset and found many options for addressing the situation. Eventually she made a move by choosing to focus on gratitude. She said, "I can focus on gratitude at this time." Over the following days, she wrote journal prompts that would support a mindset of gratitude. The teachers and I each completed the prompts. This is what Virginia was referring to in her interview when she connected "seeing things differently" with "analyz[ing] not only why we did the activity, but what the activity produced." In this case, seeing "what an activity produced" went beyond the cognitive outcomes of the activity; Virginia connected personally to what was

produced from Ana's gratitude activity. In an earlier workshop, Virginia provided more detail on this experience:

> I have to tell you Ana, the being aware or having the mindset of gratefulness is something that I realized I needed to practice more. So, thank you for this assignment because It made me more cognizant of things that I was thankful for, like, since I started answering the questions.

Virginia described a difficult experience cleaning the grounds of her church. She continued:

> And so, on the way home I said, I'm so thankful for cloudiness and a cool morning to do a nasty job. I found gratefulness in something that was very unpleasant. So, thank you for reminding me of that.

It's important to connect this example with Virginia's comment about seeing things differently and understanding what an activity produced. This personally meaningful experience helped Virginia see the indeterminacy of the outcomes of the activity; it created a unique and personal experience in her own life that couldn't be predicted through the initial activity design.

In the next workshop, we continued to discuss our experiences with the gratitude workshop. Ana told us:

> I think almost all the questions I was like putting it's from my mind that I had, I was facing during this crisis, you know, mostly, I think 90% of the questions were from related to me . . . it's really my personal questions I think . . . they all touched me, that's where it came from my heart all those questions

Ana's personal experiences clearly impacted the choices she made in the activity she designed. What happened next, however, showed that not only was the activity created from Ana's personal experiences and meaningful to Virginia, but it also supported a new interpretation of the problem identified at the very beginning of our work together: students disrespecting adults.

As we reflected on our experiences with the gratitude activity, we considered the difference between the adult and student pandemic experience. We discussed what implications these differences might have for implementing the gratitude activity with students. Virginia

described that many students have a “me mindset” and do not recognize how they affect others. She suggested they might “stretch those thoughts” through gratitude practice. The results would have a ripple effect through the community, helping students become more productive citizens. The approach could be “far reaching.” Another participant, David, added, “I think it’s how they interact with the world. If they’re more grateful, they’ll have a better interaction with the people around them, the relationships will improve.” David suggested supporting positive interactions through encouraging students to express gratitude. Virginia connected David’s thought back to respecting adults: increasing the quality of interactions with others, including the teachers, might get students out of the “me mindset” and expressing gratitude could help them better understand how they are connected to others. As a group, we had come to a new interpretation of the original situation where students were demonstrating “disrespect to adults.” Rather than seeing the situation as a behavioral problem, we were seeing it as a need for gratitude, connection, and interaction. This interpretation was personally meaningful for us, as we were living in a context where connection and interaction had been limited because of the pandemic. It was one of many possible interpretations; however, it was an interpretation that was significant to our personal experiences.

The connection between the way the teachers and I came to interpret the situation also connects to the influence of the broader context on design work, an area also emphasized by Jahnke (2011, 2012). In our work together, the impact of the context was extreme: COVID-19 became a constant companion to our discussions. It was not something that we could predict ahead of time, and it was not something that we could change; it was much larger than what we were designing. However, it still significantly impacted our interpretations.

For example, our (re)interpretation of the original situation (disrespect for adults) as a need for gratitude, connection, and interaction was a possible interpretation from the beginning of our work together. However, we could not see this frame until the changes in the broader context suggested them. The result was a conversation amongst the designer (including personal beliefs, identity, and experiences), the situation, and the broader context. By acting as designers, the

teachers increased their ability to integrate each piece through personal acts of interpretation, resulting in not only designed products and increased professional knowledge, but individual sensemaking. *That* is what teachers as designers looks like from the inside out.

Embracing Indeterminacy

In this paper, I have attempted to describe what I see as the central difference between what it means for teachers to design and what it means for teachers to be designers. Designers see indeterminacy: indeterminacy in the possible ways to frame a situation and indeterminacy in how the backtalk is perceived. This way of working with and interacting with the world leaves space for the designer to make new meaning out of situation, even (or perhaps especially) if the situation is embedded in a rapidly shifting context.

Being a designer means not only tolerating indeterminacy but embracing it. This perspective on the world can help teachers manage diversity and change. Because designers are constantly creating meaning through having a conversation with the situation, the meaning they develop is directly connected to the situation as it exists at any given time. Designers look for both expected and unexpected backtalk, so when a situation changes, whether from the introduction of new technologies, a culturally diverse classroom, or a global pandemic, they are used to responding. This does not mean it is easy, and it requires a willingness to step into the unknown and accept that the situation might not respond as expected.

The imposition of the frame, by itself, suggests possible solutions and new opportunities. There is both arrogance and humility—the arrogance of bringing oneself into the problem and imposing a solution or creating a new future but also the humility in acknowledging that any frame is limited in its possible ramifications and that this somewhat ad hoc move may not lead to perfect (or even good) solutions. However, designers are optimistic that there will be a way forward. Ann Pendleton-Jullian and John Seely Brown (2018) described:

> The optimism associated with design is a **skeptical optimism**. It is an optimism shaped by questions that arise. It is not abstract or naïve. As a process that interweaves thought with action, one receives feedback from the action, and the feedback leads to new

> questions that expand understanding of the problem space. Thought is grounded through the test of theory hitting the real world. Trying out ideas leads to failures and unexpected new questions, and ultimately to greater depth, breadth, and sophistication of the response. Design activity relies on perpetual skeptical optimism. (p. 26, emphasis in original)

Designers work from a belief that, because there are limitless ways to interact with a situation, they will be able to spur effective change. Seeing things differently, whether that difference comes from purposefully looking for indeterminacy or because the situation or broader context respond unexpectedly, allows the designer to integrate the self, the situation, and the context in a personally meaningful and effective manner.

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CHAPTER 5

CONCLUSION

In this dissertation, I have moved from an analysis of literature on teachers and design, to a design-based professional development program, and finally to theoretical exploration of teachers, design, and indeterminacy. In some ways, this structure reflects levels of biblical exegesis, as described by Lee Shulman (1979):

> p'shat: explication of the plain meanings of text; d'rash: interpretation of plain meanings; remez: broader inferences based on discerning nuances or "hints" from the text; and sode: barely bridled speculation soaring effortlessly from the text and tethered loosely, if at all, to its sources. (p. 2)

Shulman characterized his writing using these four levels, and suggested that:

> The reader should be forewarned that there will appear little interpretation for the first kind, much interpretation of the second and third kinds, and occasional forays into the dangerous altitudes of the fourth (p. 2).

I believe that these three articles connect well with Shulman's description.

The first article—an analysis of a decade of literature on teachers and design—worked to identify the "plain meanings" of the literature. An interpretive content analysis of central terms and constructs, and a network analysis of co-authorship and citation practices resulted in 10 strands of literature around teachers and design, each describing a different perspective on what, how, when, and why teachers design. The literature focused primarily on the external design activities of teachers. In other words, the literature was about designing, not necessarily about what it means to be a designer.

The next article built on the literature on teachers and design through an analysis of a design-based professional development (PD) program. The program was my own interpretation of what it means for teachers to be designers; I believed design could be empowering for teachers and could help them work effectively in difficult contexts. Much of this article focused on describing what happened in the PD program as an act of sensemaking, where each participant

interpreted our work in personally significant ways. The case highlighted how two elements of design, epistemic diversity and framing, supported a designerly type of sensemaking. Teachers explored diverse interpretations through epistemic diversity. Then, the need to design something using these interpretations pushed them to select an actionable frame and put it on the problem, further refining their interpretations. The frame redefined the problem at the same time as offering potential solutions, providing teachers with a way to move forward in their practice.

Finally, in the third article, I attempted to use “nuances and ‘hints’” from both the academic literature and the case study to draw a broader set of conclusions about what it means for teachers to be designers. I considered what was both difficult and meaningful for the participating teachers and combined this with other insights from design literature. I focused on the indeterminate nature of design, and how seeing, and even looking for, indeterminacy can open up space for personally meaningful interpretations that lead to action. The design process supports new ways of being and working, allowing teachers space to productively integrate their personal identities, beliefs, and passions with the needs of their students—even (or perhaps especially) during a pandemic.

I believe that this trio of journal articles provide a rich and nuanced vision of the relationship between teachers and design, contributing to the literature on teachers as designers as well as to the broader field of design scholarship.

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APPENDIX A

DETAILED DESCRIPTION OF LITERATURE SELECTION

Our goal in this literature review was to understand the structure of the academic literature that describe *teachers as designers*. A full, systematic literature review is particularly difficult on this topic because the word “design” is used so broadly in the literature (such as in terms like “research design”). Given the range of ways these terms are used (many of which are not relevant to our focus), we developed systematic guidelines to focus and narrow our search. Specifically, we developed our decision matrix to best meet the specific goal of the article—that of mapping the range of literature that is relevant to the idea of teacher as designer. The resulting selection and analysis process enabled us to scan a broad swath of the literature at the same time as tightly focus on the topic. In this we followed Walsh and Downe’s (2005) description of an iterative process that is refined through the final stages of the synthesis to “create a more or less precise research question, to determine which databases and other sources to search, and decide the inclusion and exclusion criteria for the studies located” (p. 207). Thus, there was a systematic yet open-ended aspect (Booth, Sutton, and Papaioannou, 2016) to our process. This is described in greater detail below.

Scoping Search

The literature review began with a desire to understand how “design” is applied in education, particularly concerning teachers. We were interested in the general application of the idea of design to teacher’s work rather than specific practices such as instructional design or lesson planning.

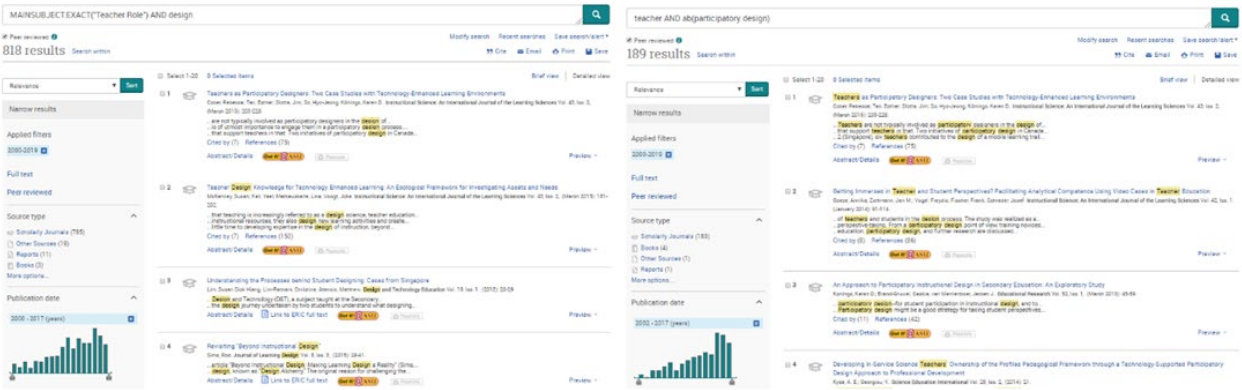
Focusing Research

An initial scoping search (Booth et al., 2016) focused on academic journal articles on design and education. Eventually, we narrowed the search to focus on teachers. We searched the Educational Resources Information Center (ERIC) database with the following phrases (see Figure A1):

- MAINSUBJECTEXACT(“Teacher Role”) AND design
- Teacher AND ab(participatory design)

Figure A1

Initial Exploration in ERIC database



After a review of the type of literature that resulted from these searches, we observed that there were many ways teachers were framed as designers and believed it would be useful to provide a map of this topic. We chose to focus on only the most influential literature that explicitly discussed teachers and design.

Based on these initial findings, we noticed that the literature did not include an in-depth analysis of the differences and connections across work on teachers and design. We wrote the following initial research questions (these questions changed as we learned more about the literature):

- How are teachers framed as designers in the academic literature?
- What do teachers design, and who do they design with?
- What are the core ideas in the literature on teachers and design?

Selecting Databases and Search Terms

We evaluated several databases in the process of finalizing our search tools. Essentially, this involved an iterative process of developing a range of search queries across a range of databases to check for: (a) whether a predetermined set of sensitivity articles showed up in the results; (b) the overall quality of the search results in terms of relevance of the articles that were listed; and (c) the ability to sort records by an indicator of impact and export bulk records for further analysis.

We identified four articles (Jordan, 2016; Kali, McKenney, & Sagy, 2015; Könings, Seidel, & van Merriënboer, 2014; Razzouk & Shute, 2012) to test the sensitivity of our search terms. These four articles were selected to represent an initial range of results we hoped to capture (each addressed teachers and design from a different perspective).

We then explored a range of databases, systematically and iteratively testing different search queries to find the best databases to include in a broader and more systematic search. Each database was searched multiple times to identify the search terms that would produce results that best met the goals of this study. We describe the process for each database below:

1. *Publish or Perish* (Harzing, 2007) allowed us to pull a range of different databases (*Crossref, Google Scholar, Microsoft Academic*). *Publish or Perish* searches of *Crossref* were limited to just 200 results making it less than ideal. Moreover, the *Crossref* web app did not allow the export of bulk records. *Google Scholar* searches included a large number of irrelevant responses and did not identify the sensitivity articles. Searches on *Microsoft Academic* were more focused and relevant, identifying all sensitivity articles except for one. Thus, we decided to include *Microsoft Academic* in our search.
2. *ERIC:* ERIC did not provide citation statistics, making it difficult to sort results by approximate impact.
3. *Web of Science* (Clarivate Analytics)*:* Each search of Web of Science included all four sensitivity articles and the interface provided information on citation counts. We added this database to our list.
4. *Scopus* (Elsevier): Several searches of *Scopus* were conducted to identify a query that included all sensitivity articles. This database was included in our list.

Thus, our final list included *Microsoft Academic, Web of Science, and Scopus.* Specifics of the scoping search queries and screenshots of results can be provided upon request.

Full Search

Prior to conducting a full search for the literature to be included in this research, we specified the kind of articles we were looking for. Specifically, we were interested in finding research

literature that (1) discussed design approaches or techniques to solving educational problems; (2) focused on K-12 education and discussed design as it applied to teachers; and (3) included a complete definition or description of design or a design-related construct. Our initial searches focused on academic journal articles only. However, after an initial review of the results, we expanded the search to include gray literature such as conference papers, books, and book chapters. In this section, we describe both journal article and gray literature searches by database. The overall selection process included:

1. Querying the database
2. Reviewing the titles of each result and determining whether the publication might be relevant to this research. In this stage, we only removed publications that were clearly out of scope (title sift).
3. Combining the results from all three databases and removing duplicates.
4. Reviewing abstracts of the remaining literature and removing those that were clearly out of scope (abstract sift).
5. Reviewing the full text of remaining publications and removing those that did not fit our criteria (full text sift).

We searched *SCOPUS*, *Web of Science*, and *Microsoft Academic* for both journal articles and gray literature. Initial attempts were made to sort publications by citations per year, but this proved practically difficult in many cases because of the way the databases were organized (*Microsoft Academic* was an exception). Cut-offs for inclusion by citation count were determined based on the goal of collecting approximately 100 pieces of literature per database in the title sifting phase.

Database Search and Title Sift

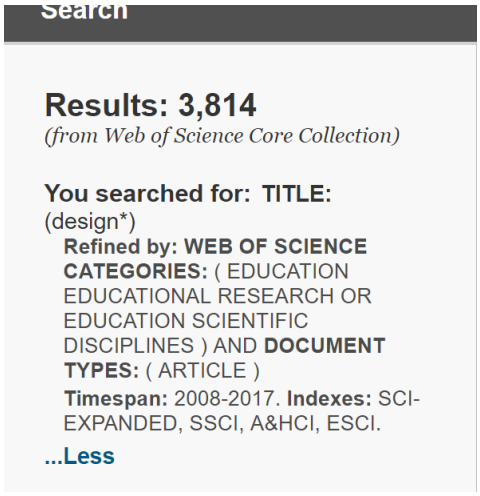
Web of Science

Initial exploration of *Web of Science* showed almost no relevant gray literature results. Thus, *Web of Science* was used exclusively for journal article searches. First, the database was queried for (design*) in title and filtered by education categories (see Figure A2). Articles were

sorted by highest citation count. Titles of 520 articles were reviewed (each had at least 12 citations), resulting in 70 plausibly relevant articles.

Figure A2

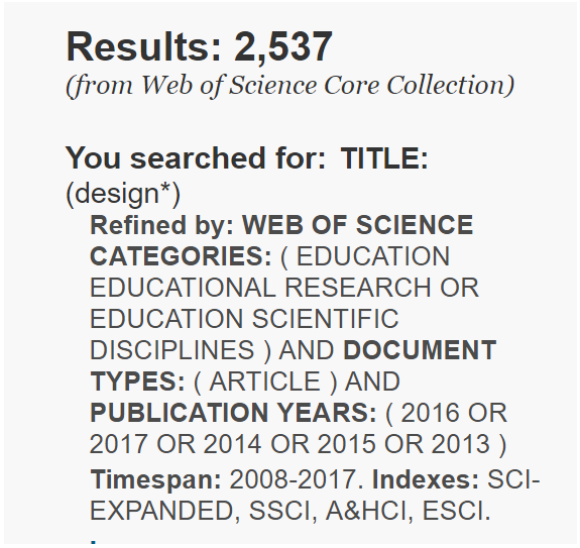
Web of Science Query 1



As more recent publications have had less time to accumulate citations, an additional search was conducted for articles published after 2013 (see Figure A3). We reviewed 315 articles that had at least 6 citations, resulting in 20 articles moving on to the abstract analysis phase.

Figure A3

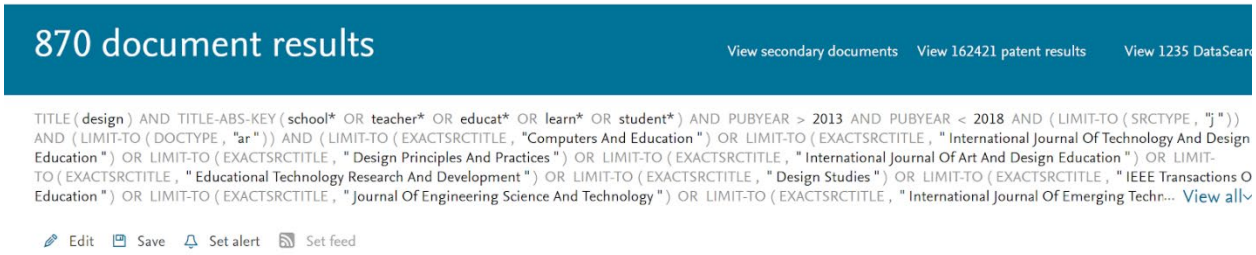
Web of Science Query 2 (2013–2017)



SCOPUS. *SCOPUS* was searched in two phases: first, academic journal articles and second, gray literature. Unlike *Web of Science*, *SCOPUS* did not have the capability of filtering by subject area. Thus, in addition to querying the word (design*) in the title, the query also included (school* OR teacher* OR educat* OR learn* or student*) in the title, abstract, or keywords. For the journal article search, we filtered the results by design or education-related journals (the title of the journal included words related to design and/or education; see Figure A4).

Figure A4

SCOPUS Journal Article Query



The results still included many general design articles that were not education related. As we conducted the title sift, we excluded articles that were clearly from classic design fields such as architectural design or urban design. However, at this stage we kept titles we were unsure about.

We reviewed 366 articles with at least 12 citations, resulting in 57 articles. Then, we reviewed 112 articles published after 2013 that had at least five citations, resulting in 10 additional articles.

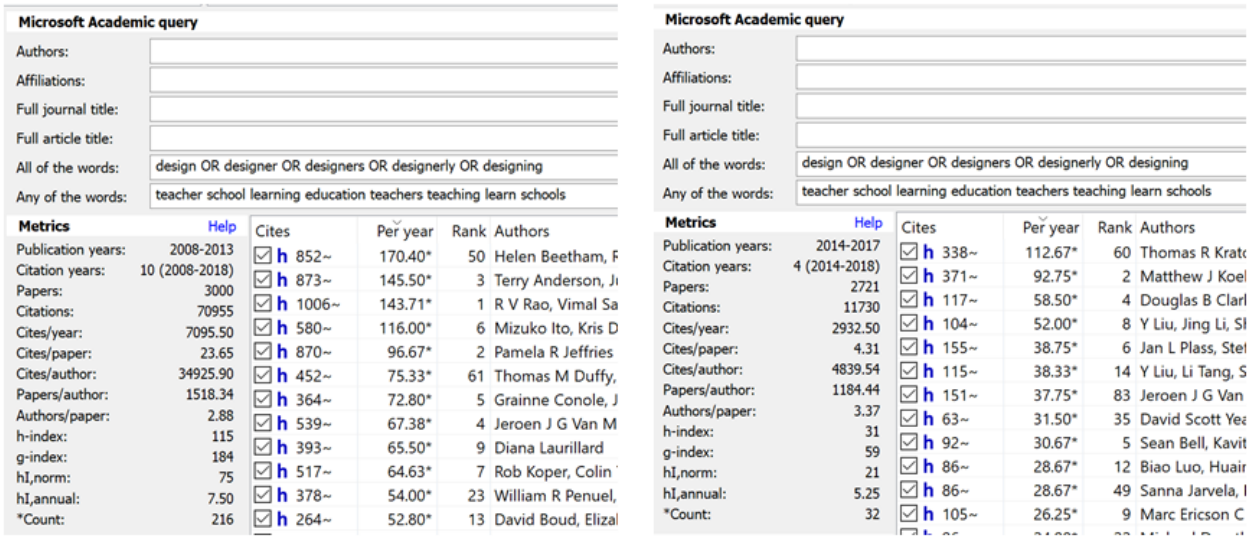
We searched for gray literature in a separate search because we would not be able to use the journal filtering method for focusing on education publications. We reviewed 917 titles with at least 12 citations, resulting in 41 publications. Then we reviewed 88 publications with at least 5 citations, resulting in 13 additional publications.

Microsoft Academic

We searched for academic journal articles in *Microsoft Academic* in two phases in order to stay beneath search maximums of *Publish or Perish* (Harzing, 2007). Results were then exported, combined, and sorted by citations per year. See Figure A5 for statistics of each query.

Figure A5

Microsoft Academic queries (through Publish or Perish)



This search resulted in 1740 journal articles. Three-hundred two articles included at least six citations per year, resulting in 46 articles after title sift. Note, the threshold for inclusion was higher for Microsoft Academic because publication citation counts were higher than citation counts reported in other databases.

A separate gray literature search with the same search terms resulted in 47 articles with at least six citations per year. After reviewing titles, 24 remained in the corpus.

Abstract Sift

All publications selected in the title sift phase were imported to *RefWorks* for duplicate removal and abstract access. After removing duplicates across databases, 234 pieces of literature remained in the corpus. We read each abstract and removed publications that were clearly out of the scope of this research. This resulted in 74 total publications for continued review.

Full Text Sift and Revising Research Questions

We completed the full text sift in two phases: first, for academic journal articles and second, for gray literature. After review of the full text of the academic articles we created a summary of each article. This summary included: problem for design, who does the designing, definitions or constructs provided, general notes, and whether it meets the criteria for inclusion. See Table A1 for detailed information by publication.

We identified 17 articles that met the criteria fully and 11 that provided a strong description of a design-related concept but did not explicitly define the construct or were special publications such as introductions to special journal issues (see Table A1). At this phase, we removed 18 journal articles from our corpus because they clearly did not meet our inclusion criteria. An additional article was removed because we were not able to access the full text. We reviewed abstracts or introductions for 75 gray literature publications such as books, book chapters, and conference papers. We removed general reports, textbooks, dissertations, and conference posters. After reviewing the full text of the publications, 26 publications remained in our corpus.

There were 14 publications in which it was not clear whether they met the inclusion criteria, including several special issue introductions. Following the iterative approach described by Walsh and Downe (2005), we revisited our research questions in light of what we had discovered through the full text sift. We rewrote the research questions as follows:

1. What are the (current) major strands of research concerning educators as designers? What are the differences/commonalities across strands?
2. How do the strands of research use and define “design” and related constructs?
3. What are the goals and outcomes of framing educators as designers?

After reviewing the special issue introductions, we decided these introductory articles were a valuable addition to the literature and so included them in the corpus. For the remaining articles, we consulted our revised research questions and re-evaluated each piece to determine whether it would help us answer the research questions. In particular, we looked for pieces that might

represent an area that contrasts with the literature already identified. Our final set of literature included 38 publications (27 journal articles, two conference papers, two edited books, one book chapter, and four full books). Two journal articles were added during the analysis stage as will be described below.

Table A1

Notes and Results from Full Text Sift of Publications

Publication	Publication Type	Problem for Design	Who is Designing	Definition/ Constructs Given	Notes	Meets Criteria? (if no, exclusion reason)[a]	Final Inclusion Decision
Agyei, D. D., & Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service mathematics teachers through collaborative design. Australasian Journal of Educational Technology, 28(4), 547–564. https://doi.org/10.14742/ajet.827	Journal Article	developing math TPCK	pre-service teachers	design teams	learning technology by design	Yes	Yes
Altay, B. (2014). User-centered design through learner-centered instruction. Teaching in Higher Education, 19(2), 138–155. https://doi.org/10.1080/13562517.2013.827646	Journal Article	teaching interior design students human-centered design	researchers/professors	user-centered design	pedagogical approach for design	No (2)	No
Bang, M., & Vossoughi, S. (2016). Participatory Design Research and Educational Justice: Studying Learning and Relations Within Social Change Making. Cognition and Instruction, 34(3), 173–193. https://doi.org/10.1080/07370008.2016.1181879	Journal article	social change	practitioners, students, families, etc.	participatory design research	focus on social justice; less descriptions of teachers specifically but good discussion of participatory design research	Maybe- Yes	Yes (valuable article for participatory design research)
Bennett, S., Agostinho, S., & Lockyer, L. (2015). Technology tools to support learning design: Implications derived from an investigation of university teachers' design practices. Computers & Education, 81, 211–220. https://doi.org/10.1016/j.compedu.2014.10.016	Journal Article	higher ed courses (partly online)	higher ed professors	learning design (good detail)		No (2)	No
Binkhorst, F., Handelzalts, A., Poortman, C. L., & van Joolingen, W. R. (2015). Understanding teacher design teams - A mixed methods approach to developing a descriptive framework. Teaching and Teacher Education, 51, 213–224.	Journal Article	teacher design teams creating materials	teachers + university professor	Teacher Design Teams (TDT's)-limited		Maybe	No (limited focus on teachers)

Boschman, F., McKenney, S., & Voogt, J. (2014). Understanding decision making in teachers' curriculum design approaches. Educational Technology Research and Development: ETR & D, 62(4), 393–416. https://doi.org/10.1007/s11423-014-9341-x	Journal Article	online/offline K reading activities	team of teachers	design interactions	framed in TPCK	Yes	Yes
Boschman, F., McKenney, S., & Voogt, J. (2015). Exploring teachers' use of TPACK in design talk: The collaborative design of technology-rich early literacy activities. Computers & Education, 82, 250–262. https://doi.org/10.1016/j.compedu.2014.11.010	Journal Article	lessons with effective use of technology (TPACK)	group of teachers	design decisions, design problems	collaborative curriculum design/design talk	Yes	Yes
Burdick, A., & Willis, H. (2011). Digital learning, digital scholarship and design thinking. Design Studies, 32(6), 546–556. https://doi.org/10.1016/j.destud.2011.07.005	Journal Article	21st century skills/digital learning, new pedagogy/educational systems	educators, students	design thinking (excellent)	from design field; good overview of application to education	Yes (if can be considered "education literature")	Yes
Chien, Y.-T., Chang, C.-Y., Yeh, T.-K., & Chang, K.-E. (2012). Engaging pre-service science teachers to act as active designers of technology integration: A MAGDAIRE framework. TEACHING AND TEACHER EDUCATION}, 28(4), 578–588. https://doi.org/10.1016/j.tate.2011.12.005	Journal Article	integrating technology into science	pre-service teachers	tpck, situated cognition (NO DESIGN)	no explanation of design	No (3)	No
Cobb, P., & Jackson, K. (2012). Analyzing Educational Policies: A Learning Design Perspective. Journal of the Learning Sciences, 21(4), 487–521. https://doi.org/10.1080/10508406.2011.630849	Journal Article	design policies that support learning (example: principal as instructional leaders in math)	researcher, policy maker	design for learning (brief)	interesting application of design but less clarification as to what design means.	Maybe	no (focus on researchers and policy makers)
Cobb, P., Zhao, Q., & Dean, C. (2009). Conducting Design Experiments to Support Teachers' Learning: A Reflection From the Field. Journal of the Learning Sciences, 18(2), 165–199. https://doi.org/10.1080/10508400902797933	Journal Article	PD for math teachers	researcher	design research	researchers are designers	No (2)	No
Cober, R., Tan, E., Slotta, J., So, H.-J., & Könings, K. D. (2015). Teachers as participatory designers: two case studies with technology-enhanced learning environments. Instructional Science, 43(2), 203–228. https://doi.org/10.1007/s11251-014-9339-0	Journal Article	ed tech software	teachers+software developers/technicians	participatory design (excellent)	good literature to review on design in ed	Yes	Yes

Cviko, A., McKenney, S., & Voogt, J. (2014). Teacher roles in designing technology-rich learning activities for early literacy: A cross-case analysis. Computers & Education, 72, 68–79. https://doi.org/10.1016/j.compedu.2013.10.014	Journal Article	ed tech software	teachers	teachers as co-designers/re-designers	construct definitions weak; research into teachers experiences interesting	No (3)	No
Davis, E. A., Beyer, C., Forbes, C. T., & Stevens, S. (2011). Understanding pedagogical design capacity through teachers' narratives. TEACHING AND TEACHER EDUCATION, 27, 797–810. Retrieved from https://www.sciencedirect.com/science/article/pii/S0742051X11000060	Journal Article	curriculum adaptations	teachers (alone)	curriculum	key phrases: "teachers as curriculum designers," "pedagogical design capacity" —not well defined, but interesting.	No (3)	YES: After reviewing additional literature (including book chapters), identified this as an important line of work[b]
Dempster, J. A., Benfield, G., & Francis, R. (2012). An academic development model for fostering innovation and sharing in curriculum design. Innovations in Education and Teaching International, 49(2), 135–147. https://doi.org/10.1080/14703297.2012.677595	journal article	curriculum	tutors and learners	course design intensive	evaluation of academic development model	No (2)	No
Dorst, K. (2011). The core of "design thinking" and its application. Design Studies, 32(6), 521–532. https://doi.org/10.1016/j.destud.2011.07.006	Journal Article	theoretical	No specifics (basically everyone)	design thinking (excellent)	great DT description; no ed application	No (1)	No
Goodyear, P., & Dimitriadis, Y. (2013). In medias res : reframing design for learning. Research in Learning Technology, 21(0). https://doi.org/10.3402/rlt.v21i0.19909	journal article	learning	teacher	design for learning, design, learning design	good theoretical overview	Yes	Yes
Hauge, T. E. (2014). Uptake and use of technology: bridging design for teaching and learning. Technology, Pedagogy and Education, 23(3), 311–323. https://doi.org/10.1080/1475939X.2014.942750	Journal Article	mathematics teaching; online resources	teachers	design; design for learning; design for teaching	constrast Simon and Schon	Yes	Yes
Holmberg, J. (2014). Studying the process of educational design – revisiting Schön and making a case for reflective design-based research on teachers' "conversations with situations." Technology, Pedagogy and Education, 23(3), 293–310. https://doi.org/10.1080/1475939X.2014.942748	Journal Article	theoretical	teachers	design (Schon perspective; excellent)	Schon and reflective design for DBR (focus more on teacher's processes)	Yes	Yes

Huizinga, T., Handelzalts, A., Nieveen, N., & Voogt, J. M. (2014). Teacher involvement in curriculum design: Need for support to enhance teachers' design expertise. JOURNAL OF CURRICULUM STUDIES}, 46}(1}), 33–57}. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/00220272.2013.834077	Journal Article	curriculum	team of teachers	teacher design expertise; curriculum design expertise		Yes	Yes
Kalantzis, M., & Cope, B. (2010). The Teacher as Designer: Pedagogy in the New Media Age. E-Learning and Digital Media, 7(3), 200–222. https://doi.org/10.2304/elea.2010.7.3.200	Journal Article	new learning for knowledge society	teachers	loosely: learning by design	good theoretical article on learning by design background, but no clear construct definitions	No (3)	No
Kali, Y., Goodyear, P., & Markauskaite, L. (2011}). Researching design practices and design cognition: contexts, experiences and pedagogical knowledge-in-pieces. Learning, Media and Technology, 36}(2, SI}), 129–149}.	Journal Article	educational technology/design course	teachers (grad students), professor	loosely: design thinking, design cognition	good lit review but no clear construct definition	No (3)	No
Kali, Y., McKenney, S., & Sagy, O. (2015). Teachers as designers of technology enhanced learning. Instructional Science, 43(2), 173–179. https://doi.org/10.1007/s11251-014-9343-4	Journal Article	technology enhanced learning	teachers	teachers as designers of technology enhanced learning	intro to special issue. Not a full article, but good background of this strand of research	Maybe (pending decision on special issue intros/conclusions)	Yes (special issue introduction)
Kirschner, P. A. (2015). Do we need teachers as designers of technology enhanced learning? Instructional Science, 43(2), 309–322. https://doi.org/10.1007/s11251-015-9346-9	Journal Article	theoretical	teachers	teach competencies (design competencies)	critical view of special issue	Maybe (pending decision on special issue intros/conclusions)	Yes (special issue critique)
Koh, J. H. L., Chai, C. S., Benjamin, W., & Hong, H.-Y. (2015). Technological Pedagogical Content Knowledge (TPACK) and Design Thinking: A Framework to Support ICT Lesson Design for 21st Century Learning. The Asia-Pacific Education Researcher, 24(3), 535–543. https://doi.org/10.1007/s40299-015-0237-2	Journal Article	ICT	teachers	design thinking, design thinking for teachers	good lit review	Yes	Yes

Kong, S. C., & Song, Y. (2013). A principle-based pedagogical design framework for developing constructivist learning in a seamless learning environment: A teacher development model for learning and teaching in digital classrooms. British Journal of Educational Technology: Journal of the Council for Educational Technology, 44(6), E209–E212. https://doi.org/10.1111/bjet.12073	Journal Article	constructivist learning environments	teachers	pedagogical design	limited construct definition	No (3)	No
Könings, K. D., Bovill, C., & Woolner, P. (2017). Towards an interdisciplinary model of practice for participatory building design in education. European Journal of Education. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/ejed.12230/full	Journal Article	school building	multiple stakeholders (teachers, students, architects)	participatory building design	new construct—somewhat limited in description but important area	Maybe	Yes (important area with limited publications)
Könings, K. D., Brand-Gruwel, S., & van Merrienboer, J. J. G. (2010). An approach to participatory instructional design in secondary education: an exploratory study. EDUCATIONAL RESEARCH, 52(1), 45–59.	Journal Article	instruction (??)	teachers + students	participatory design	brief construct definition	Maybe	Yes (strong enough construct definition)
Könings, K. D., Seidel, T., & van Merriënboer, J. J. G. (2014). Participatory design of learning environments: integrating perspectives of students, teachers, and designers. Instructional Science, 42(1), 1–9. https://doi.org/10.1007/s11251-013-9305-2	Journal Article	learning environments	students, teachers, instructional designers	COOP: Combination-of-Perspectives Model	intro to special issue-not full article	Maybe (pending decision on special issue intros/conclusions)	Yes (special issue introduction)
Laurillard, D., Charlton, P., Craft, B., Dimakopoulos, D., Ljubojevic, D., Magoulas, G., … Whittlestone, K. (2013). A constructionist learning environment for teachers to model learning designs. Journal of Computer Assisted Learning, 29(1), 15–30. https://doi.org/10.1111/j.1365-2729.2011.00458.x	Journal Article	technology enhanced learning	university professors	learning design (weak)	higher ed; presents learning design software tool	No	No
Leiringer, R., & Cardellino, P. (2011). Schools for the twenty-first century: school design and educational transformation. British Educational Research Journal, 37(6), 915–934. https://doi.org/10.1080/01411926.2010.508512	Journal Article	school buildings	community participatory	user participation in school design (weak)	from different area—participatory design of diverse stakeholders; but not as clear of construct definition	Maybe	No, limited focus on teachers

Ling, L. M., & Marton, F. (2011). Towards a science of the art of teaching: Using variation theory as a guiding principle of pedagogical design. International Journal for Lesson and Learning Studies, 1(1), 7–22. https://doi.org/10.1108/20468251211179678	Journal Article	lessons	teachers	no definition (about pedagogy design)		No (3)	No
Lockyer, L., Heathcote, E., & Dawson, S. (2013). Informing Pedagogical Action: Aligning Learning Analytics With Learning Design. The American Behavioral Scientist, 57(10), 1439–1459. https://doi.org/10.1177/0002764213479367	Journal Article	learning design plan (pedagogical plan)	university professors	learning design (excellent)	higher ed	No (1)	No
MacLean, P., & Scott, B. (2011). Competencies for learning design: A review of the literature and a proposed framework: Competencies for learning design. British Journal of Educational Technology: Journal of the Council for Educational Technology, 42(4), 557–572. https://doi.org/10.1111/j.1467-8535.2010.01090.x	Journal Article	learning design plan	professional designers	learning design (excellent)	like instructional design—competencies for professionals	No (2)	No
McKenney, S., & Mor, Y. (2015). Supporting teachers in data-informed educational design. British Journal of Educational Technology: Journal of the Council for Educational Technology, 46(2), 265–279. https://doi.org/10.1111/bjet.12262	Journal Article	learning design	teachers	learning design; teacher-led design inquiry of learning	ed tech/learning analytics connection	Yes	Yes
McKenney, S., Kali, Y., Markauskaite, L., & Voogt, J. (2015). Teacher design knowledge for technology enhanced learning: an ecological framework for investigating assets and needs. Instructional Science, 43(2), 181–202. https://doi.org/10.1007/s11251-014-9337-2	Journal Article	classroom, lessons, etc.	teachers	design, teachers as designers (excellent)	Broad lit review!	Yes	Yes
Molina, M., Castro, E., Molina, J. L., & Castro, E. (2011). An Approach to Design Research through Teaching Experiments. ENSENANZA DE LAS CIENCIAS, 29(1), 75–87.*	Journal Article					No (unable to access)	No
Mor, Y., & Craft, B. (2012). Learning design: reflections upon the current landscape. Research in Learning Technology, 20(0), 85–94. https://doi.org/10.3402/rlt.v20i0.19196	Journal Article	theoretical/summative	(teachers)	learning design (review of various definitions/comparisons)		Yes	Yes
Mor, Y., Craft, B., & Hernández-Leo, D. (2013). Editorial: The art and science of learning design. Research in Learning Technology, 21(0). https://doi.org/10.3402/rlt.v21i0.22513	journal article	learning	educators	learning design, design for learning	good introduction to teaching as design	Yes	Yes

Mor, Y., Ferguson, R., & Wasson, B. (2015}). Editorial: Learning design, teacher inquiry into student learning and learning analytics: A call for action. British Journal of Educational Technology: Journal of the Council for Educational Technology, 46}(2, SI}), 221–229}.	Journal Article	theoretical	(teachers)	learning design and connection to general design	special issue intro	Maybe (if including special issue intros)	Yes
Mor, Y., Warburton, S., & Winters, N. (2012). Participatory pattern workshops: a methodology for open learning design inquiry. Research in Learning Technology, 20(0), 163–175. https://doi.org/10.3402/rlt.v20i0.19197	journal article	learning	practitioners	design narratives,		Yes	Yes
Penuel, W. R., & Gallagher, L. P. (2009). Preparing Teachers to Design Instruction for Deep Understanding in Middle School Earth Science. Journal of the Learning Sciences, 18(4), 461–508. https://doi.org/10.1080/10508400903191904	Journal Article	science curriculum	teachers (partly as re-designers)	design arena of curriculum use (brief)	compares PD approaches. Construct is less clear	Maybe	Yes, represents distinct field of work
Penuel, W. R., Fishman, B. J., Cheng, B. H., & Sabelli, N. (2011). Organizing Research and Development at the Intersection of Learning, Implementation, and Design. Educational Researcher , 40(7), 331–337. https://doi.org/10.3102/0013189X11421826	Journal Article	theoretical		DBIR	good DBIR overview	No (2)	No
Penuel, W. R., Gallagher, L. P., & Moorthy, S. (2011). Preparing Teachers to Design Sequences of Instruction in Earth Systems Science: A Comparison of Three Professional Development Programs. American Educational Research Journal, 48(4), 996–1025. https://doi.org/10.3102/0002831211410864	Journal Article	science instruction	teachers	understanding by design (program)	not focused on actual designing; mostly results of designing	No (1)	No
Persico, D., & Pozzi, F. (2015). Informing learning design with learning analytics to improve teacher inquiry: Informing LD with LA to improve teacher inquiry. British Journal of Educational Technology: Journal of the Council for Educational Technology, 46(2), 230–248. https://doi.org/10.1111/bjet.12207	journal article	technology integration	practitioners	learning design		Yes	Yes
Razzouk, R., & Shute, V. (2012). What Is Design Thinking and Why Is It Important? Review of Educational Research, 82}(3}), 330–348}. https://doi.org/10.3102/0034654312457429	Journal Article	theoretical	direct application to students (in conclusion)	design, design thinking		Yes	Yes
Severance, S., Penuel, W. R., Sumner, T., & Leary, H. (2016). Organizing for Teacher Agency in Curricular Co-Design. Journal of the Learning Sciences, 25(4), 531–564. https://doi.org/10.1080/10508406.2016.1207541	Journal Article	science curriculum	teachers	co-design (good)		Yes	Yes
Stolk, M. J., De Jong, O., Bulte, A. M. W., & Pilot, A. (2011}). Exploring a Framework for Professional Development in Curriculum Innovation: Empowering Teachers for Designing Context-Based Chemistry Education. RESEARCH IN SCIENCE EDUCATION}, 41}(3}), 369–388}.	Journal Article	PD	researchers	design research		No (2)	No

Sutherland, R., & Fischer, F. (2014). Future learning spaces: design, collaboration, knowledge, assessment, teachers, technology and the radical past. Technology, Pedagogy and Education, 23(1), 1–5. https://doi.org/10.1080/1475939X.2013.870107	journal article	learning spaces	various	none	special issue intro; focus on the designed space, not the process	No (3)	No
Svihla, V., Reeve, R., Sagy, O., & Kali, Y. (2015). A fingerprint pattern of supports for teachers' designing of technology-enhanced learning. Instructional Science, 43(2), 283–307. doi:10.1007/s11251-014-9342-5	Journal Article	instructional technology	teachers	teachers as designers/teacher identity of designer (weak)	construct not as explicit	maybe	Yes, represents important perspective on teachers and design
van Dooren, E., Boshuizen, E., van Merriënboer, J., Asselbergs, T., & van Dorst, M. (2014). Making explicit in design education: generic elements in the design process. International Journal of Technology and Design Education, 24(1), 53–71. https://doi.org/10.1007/s10798-013-9246-8	Journal Article	design pedagogy	expert designers	design elements		No (2)	No
Voogt, J., Laferrière, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. (2015). Collaborative design as a form of professional development. Instructional Science, 43(2), 259–282. https://doi.org/10.1007/s11251-014-9340-7	Journal Article	various	teacher teams	collaborative design (detailed)		Yes	Yes
Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., & de Vries, B. (2011). Teacher learning in collaborative curriculum design. TEACHING AND TEACHER EDUCATION}, 27(8), 1235–1244. https://doi.org/10.1016/j.tate.2011.07.003	Journal Article	lit review	lit review	teacher design teams (brief)	lit review of TDTs	maybe	Yes; strong literature review of teacher design teams
Winters, N., & Mor, Y. (2008). IDR: A participatory methodology for interdisciplinary design in technology enhanced learning. Computers & Education, 50(2), 579–600. https://doi.org/10.1016/j.compedu.2007.09.015	Journal Article	technology enhanced learning	professional designers	design (good)		No (2)	No
Yelland, N., Cope, B., & Kalantzis, M. (2008). Learning by Design: creating pedagogical frameworks for knowledge building in the twenty-first century. Asia-Pacific Journal of Teacher Education, 36(3), 197–213. https://doi.org/10.1080/13598660802232597	Journal Article	instruction	teachers	Learning by Design		Yes	Yes
Calvo, R. A. (2009). Incorporating Affect into Educational Design Patterns and Frameworks. In 2009 Ninth IEEE International Conference on Advanced Learning Technologies (pp. 377–381). https://doi.org/10.1109/ICALT.2009.88	conference report	collaborative activities	researchers/designers		might be interesting for DA	No (2)	No

Churchill, D., King, M., Webster, B., & Fox, B. (2013). Integrating learning design, interactivity, and technology. In ASCILITE-Australian Society for Computers in Learning in Tertiary Education Annual Conference (pp. 139–143). Australasian Society for Computers in Learning in Tertiary Education. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84913601566&partnerID=40&md5=9c840a26b789a2e4cc28b35e2d761a4b	conference paper	engaging digital technologies	higher ed teachers			No (2)	No
Maldonado, H., & Pea, R. D. (2010). LET's GO! to the Creek: Co-design of Water Quality Inquiry Using Mobile Science Collaboratories. In 2010 6th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education (pp. 81–87). https://doi.org/10.1109/WMUTE.2010.50	conference paper	ecological science	teachers, researchers, developers	co-design	focus on product, but has solid definitions	No (1)	No
Miao, Y., Ally, M., Samaka, M., & Tsinakos, A. A. (2014). Towards Pedagogy-Driven Learning Design: A Case Study of Problem-Based Learning Design. In Advances in Web-Based Learning – ICWL 2014 (Vol. 8613 LNCS, pp. 179–189). Springer International Publishing. https://doi.org/10.1007/978-3-319-09635-3_20	conference paper	problem-based learning	designers, teachers	learning design (constrast with instructional design)		Yes	Yes
Mor, Y., & Mogilevsky, O. (2013). Learning Design Studio: Educational Practice as Design Inquiry of Learning. In Scaling up Learning for Sustained Impact (Vol. 8095 LNCS, pp. 233–245). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-40814-4_19	conference paper	learning	teachers	design, teacher inquiry into student learning	good epistemological base	Yes	Yes
Siemens, G. (2008). Learning and knowing in networks: Changing roles for educators and designers.	conference paper	learning in networks	educators		interesting metaphors of teachers	No	No
Cope, B., & Kalantzis, M. (2015). A pedagogy of multiliteracies: Learning by design. https://doi.org/10.1057/9781137539724	book with individually authored chapters	multiliteracy pedagogy/lesson plans	teachers	learning by design; reflexive pedagogy; design	several chapters applicable; start with introduction	Yes	Yes
Lockyer, L., Bennett, S., Agostinho, S., & Harper, B. (2008). Handbook of Research on Learning Design and Learning Objects: Issues, Applications and Technologies. https://doi.org/10.4018/978-1-59904-861-1	Book with individually authored chapters				Agostinho, Conole (2009) chapters from this book	Maybe	No (Book included two book chapters reviewed; other chapters seemed less relevant)

Agostinho, S. (2009). Learning design representations to document, model, and share teaching practice. https://doi.org/10.4018/978-1-59904-861-1.ch001	book chapter	learning	designers, educators	learning design, design for learning, designing for learning, Learning Design	focus on communicating learning designs (common language), but also discusses what teachers/practitioners do to design. Cites Laurillard.	Maybe	No (mostly focused on higher ed)
Brown, M. W. (2011). The teacher—tool relationship: Theorizing the design and use of curriculum materials. In Mathematics teachers at work (pp. 37–56). Routledge. Retrieved from https://www.taylorfrancis.com/books/e/9781135855635/chapters/10.4324%2F9780203884645-11	book chapter	use of curriculum	teachers	teaching as design	jazz metaphor	Yes	Yes
Chow, J.-Y., Renshaw, I., Button, C., Davids, K., & Keat, C. W. (2012). Complexity Thinking in Physical Education (pp. 121–134). Routledge. https://doi.org/10.4324/9780203126455	book chapter	non-linear pedagogy	physical educators	non-linear pedagogy	no design construct definition	No (3)	No
Conole, G. (2009). The Role of Mediating Artefacts in Learning Design. https://doi.org/10.4018/978-1-59904-861-1.ch008	book chapter	learning activities	designer (some adaptations by "tutor")	learning design	use of activity theory/CHAT	No (2)	No
Roschelle, J., Knudsen, J., & Hegedus, S. (2010). From new technological infrastructures to curricular activity systems: Advanced designs for teaching and learning (pp. 233–262). https://doi.org/10.1007/978-0-387-88279-6_9	book chapter	tech integration/curricular activity system, classroom practices/routines	researchers	advanced design	focus on technology design	No (2)	No
Koh, J. H. L., Chai, C. S., Wong, B., & Hong, H.-Y. (2015). Design Thinking for Education: Conceptions and Applications in Teaching and Learning (pp. 1–131). https://doi.org/10.1007/978-981-287-444-3	book (individually authored chapters)		Everyone- some chapters teacher-focused	design thinking	focus on chapter 1, 5, and 6	Yes	Yes
Brown, M. W. (2008). Mathematics Teachers at Work (pp. 17–36). Routledge. https://doi.org/10.4324/9780203884645*	book					No (unable to access)	No
Conole, G. (2013). Designing for learning in an open world. https://doi.org/10.1007/978-1-4419-8517-0	book	learning activities	teachers/designers	learning design	focus on practitioner-oriented chapters	Yes	Yes

Laurillard, D. (2012b). Teaching as a design science: Building pedagogical patterns for learning and technology (pp. 1–258). New York, NY: Routledge. https://doi.org/10.4324/9780203125083	book	learning	teachers	pedagogical patterns	Yes	Yes
Mor, Y., Mellar, H., Warburton, S., & Winters, N. (2014). Practical Design Patterns for Teaching and Learning with Technology. (Y. Mor, H. Mellar, S. Warburton, & N. Winters, Eds.) (pp. 1–338). https://doi.org/10.1007/978-94-6209-530-4	book	learning	educators	learning design	Yes	Yes
Woolner, P. (2010). The Design of Learning Spaces. Retrieved from http://eprint.ncl.ac.uk/pub_details2.aspx?pub_id=153651	book	physical school buildings	community including students, teachers	participatory design	Yes	Yes

Note. An initial review of full texts resulted in questions about inclusion of some publications (for example, introductory articles from special editions of journals and publications that provided partial construct definitions). These publications were labeled as "maybe" in the "Meets Criteria" column. The final decision for inclusion was made after reviewing all the literature and revising the research questions.

[a]Numbers in parenthesis represent the inclusion criteria that the publication did not meet. The criteria was: (1) discussed design approaches or techniques to solving educational problems; (2) focused on K-12 education and discussed design as it applied to teachers; and (3) included a complete definition or description of design or a design-related construct. [b] Davis et al. (2011) was initially removed from the corpus. However, after further review of gray literature and the references of selected literature, we determined it provided a valuable perspective on a strand of teachers and design for which we had limited literature. We decided to include it in the final corpus.

APPENDIX B

DETAILED ANALYSIS PROCESS

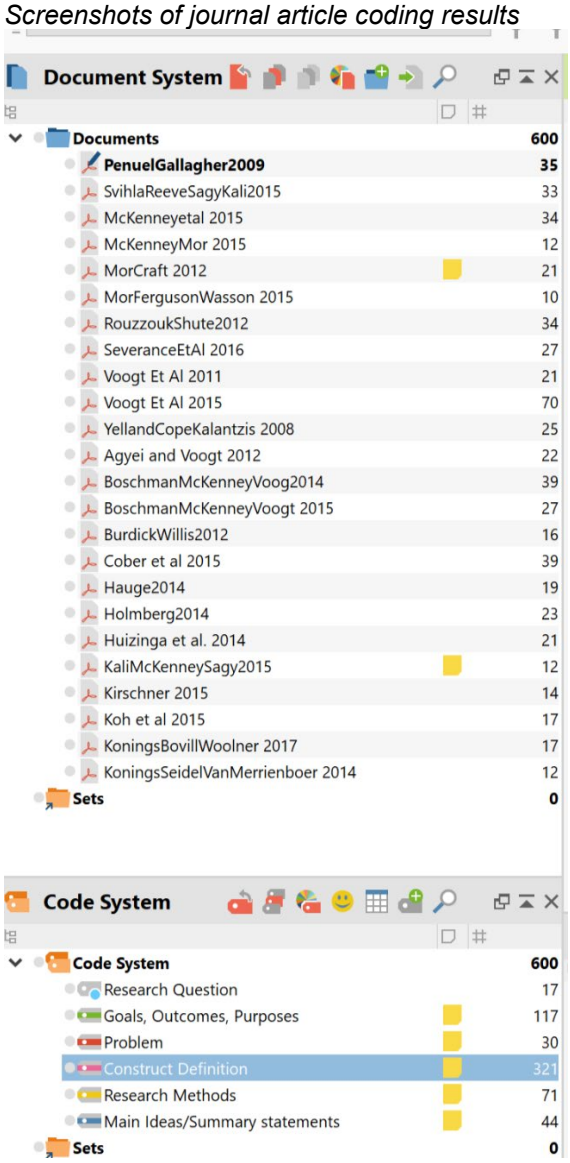
In this appendix, we detail the analysis process, including interpretive content analysis and network analysis. The initial analysis of the literature focused on understanding how each publication described teachers as designers. First, each journal article was coded with structural codes (see Table B2 and Figure B1).

Table B1
Initial Coding Protocol (Structural Codes)

Structural Code	Code Memo
Research Question	Exact statement of research questions
Goals, Outcomes, Purposes	What is the goal of design? Why are we using design? What are the expected or actual outcomes of using design in education?
Problem	What issues are being approached by design? Why is design effective for this problem?
Construct Definition	Names and definitions/characteristics of primary concepts related to design
Research Methods	Proposed or actual research methods
Main Ideas/Summary Statements	Statements summarizing article/argument

Figure B1

Screenshots of journal article coding results



After reading each journal article, we wrote the following research questions:

1. What are the strands of scholarship that describe teachers as designers?

2. How are the strands connected conceptually?

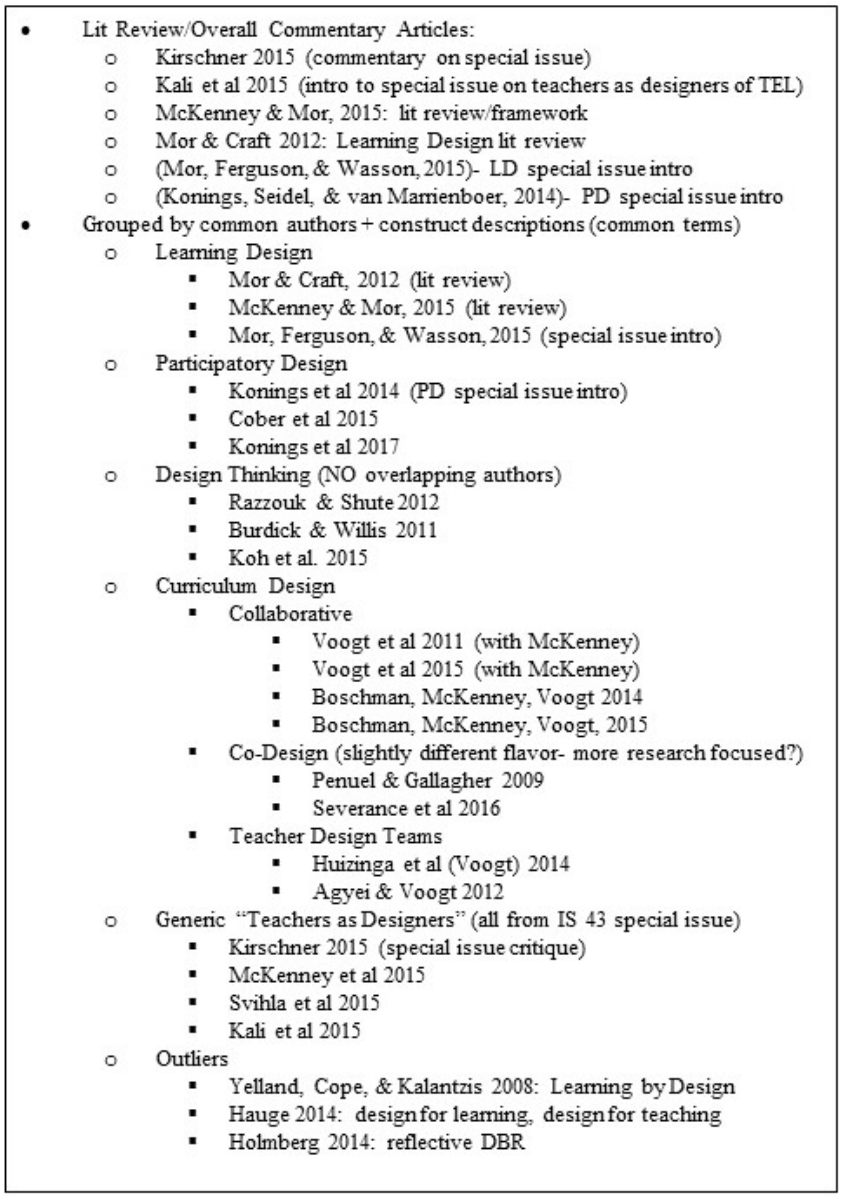
3. How does each strand apply design to teachers' work?

For the interpretive content analysis, we first focused on the constructs. We made index cards for each article, including a summary of the article as well as the constructs and definitions

identified. We compared definitions and sorted the cards to find the best match among definitions. This resulted in an initial taxonomy of journal articles (see Figure B2).

Figure B2

Initial Taxonomy of Journal Articles



Next, we wrote memos for each of the strands outlined above. The memos included descriptions of each strand and what was similar and different across publications. To deepen the analysis, additional memos were written concerning how each strand defined design, described

design processes, presented the use and purpose of design, and explained design skills or expertise.

After the initial analysis of academic journal articles, we turned to books, book chapters, and conference papers and considered whether and how this literature fit into the taxonomy we had created. In general, the gray literature seemed to fit well into the constructs. We identified significantly more literature on learning design, deepening our understanding of this strand. We also investigated the phrases “learning by design,” “design for learning,” and “design for teaching.” These terms were used in various ways in different strands. To better understand and differentiate among these terms, we identified quotes from the literature that defined and applied them. This resulted in the strands “learning by design,” “design for learning,” and “design for teaching and learning.”

We also created a new strand called “pedagogical design capacity” based on Brown (2011). Kali, McKenney, and Sagy (2015) cited Brown as a branch of work around teachers and design. Penuel and Gallagher (2009) also discussed pedagogical design capacity as an outcome of collaborative design. We turned to Kali et al.’s citations to find more insight into this line of work. They cited Davis et al. (2011), a publication that had been excluded at the full text sift because of limited construct definitions. We decided to include this publication because of the limited work we had identified on pedagogical design capacity. Further reference searches led us to Matuk, Lynn, and Eylon (2015), which was originally eliminated because it was below the citation threshold. However, it provided valuable insight into pedagogical design capacity, so we added it to the literature corpus.

Cross-Theme Analysis

After refining the literature into strands, we analyzed potential themes that might spread across strands. In particular, we explored the how, when, who, where, why, and what of design across the articles. This phase of the analysis led to Table 2 and Figure 6 presented in the paper. Other themes explored included a focus on process or products, the use of design for teacher development, design processes, evaluating design, sharing designs, and the relationship

between the design described in the literature corpus with design as described by design scholars. Although these themes led to interesting explorations, they were determined to be out of the scope of the final paper.

Network Analysis

To better understand relationships across strands (research question 2), we applied two types of network analysis: co-authorship and citation.

Co-Authorship Analysis

For the co-authorship analysis, the authors of each publications were set as nodes (77). Edges were added between each author and who they published with in the literature corpus, resulting in 420 edges total. This resulted in 12 authorship clusters. We used Gephi (2017) network analysis software to map the results. The map demonstrated the best fit after 100 iterations of an algorithm that minimizes the distance of edges connecting each node to each other node within each cluster.

Citation Analysis

We began the citation network analysis by downloading the references from *SCOPUS* for 39 of the publications. Woolner (2010) was not listed in *SCOPUS*. We contacted the author and received a reference list directly from them.

Next, we created a list of all cited authors. We sorted the list alphabetically and checked for authors with identical last names but different first names. We added an initial to the end of the last name as needed. We also checked for authors that might be listed by different names, for example “Schön, D”, “Schön, DA,” or “Schon, D,” and merged the records accordingly. We removed duplicates to create a list of all cited authors (2,941 total). Authors only cited one time were removed from the data as they provided no connections between citing literature. Nine-hundred thirty-five nodes remained. Next, we built edges between each article and the authors they cited. We removed self-citations (edges that connected articles with any of the authors) resulting in 3,953 edges.

The citation analysis map was created through *UCINET NetDraw* (Borgatti, 2002). *UCINET* provided more advanced features than *GEPHI* that made it ideal for working with large data sets. However, the visualization options were less refined, making *GEPHI* more appropriate for the co-authorship analysis. The map was created with Gower Scaling and optimized with 100 iterations of spring embedding (based on edge length, see Hanneman & Riddle, 2005).

The data used for the citation analysis map was also queried to identify the top cited authors in the literature corpus. The number of citations for each author was calculated and the authors were sorted by highest citation count (see Table B2).

Limitations of Network Analysis

Although network analysis provided a convenient way to visualize the literature on teachers and design, several limitations should be noted:

- The number of articles used to create the co-authorship map was low. A larger corpus of literature would create a more useful map. Because of this limitation, we included thematic and citation analysis methods in our analysis.
- The accuracy of the citation analysis depends on the accuracy of the *SCOPUS* database. Although extensive attempts were made to identify and adjust authors with similar last names, it is possible that some errors remained.
- All cited authors were treated equally, whether they were the 1st or 5th author. This was appropriate given that different fields often ascribe authorship differently and contextual factors often determine authorship (for example, grant funding can impose certain restrictions).
- Books often have more citations than journal articles, and authors have varying numbers of citations. For example, Yelland, Cope, and Kalantzis (2008) had fewer citations than other articles and included many self-citations, so this publication might be more connected to the literature corpus than the map illustrates.
- Large author groups may also affect the results (a greater proportion of citations are self-citations because of the large number of authors).

Table B2
Authors with More Than 9 Citations Sorted by Citation Count

Author	Citations
Voogt	40
Engeström	32
Laurillard	31
Goodyear	31
Davis	31
McKenney	30
Krajcik	30
Mor	28
Linn	25
Koehler	25
Mishra	25
Cross	24
Dimitriadis	23
Schön	23
Kali	22
Beetham	21
van Merriënboer	20
Conole	19
Penuel	19
Remillard	19
Fishman	19
Handelzalts	18
OliverM	18
Reeves	18
Marx	18
OliverR	18
McAndrew	18
Pieters	17
Nieveen	17
Winters	17
Dalziel	17
Scardamalia	16
Littlejohn	16
Agostinho	15
Barab	15
van den Akker	15
Retalis	15
Weller	15
Borko	14

BrownAL	14
Jonassen	14
Hernández-Leo	14
Falconer	14
Bransford	13
Anderson	12
Bereiter	12
Ertmer	12
Brand-Gruwel	12
Craft	12
Dorst	12
Reiser	12
Vygotsky	12
Chai	12
Sannino	12
Koper	12
Kirschner	11
Blumenfeld	11
Luckin	11
Soloway	11
Cohen	11
Shulman	11
Simon	11
Derntl	11
Harper	11
Lockyer	11
Westbroek	10
Asensio-Pérez	10
Schwartz	10
Marton	10
Sharpe	10
Scanlon	10

APPENDIX C

DETAILED DESCRIPTIONS OF STRANDS

We used interpretative content analysis to understand and define the constructs used in each strand. We compared the construct definitions of each article to establish a common description of the strand. Here we provide a detailed description of each strand.

Teachers as Designers: Teaching *is* Design

The *Teachers as Designers* strand is in some ways an umbrella term: all the strands analyzed here look at teachers as designers. However, the four publications included in this strand differed from others in that they did not describe a specific type of design. Rather, they took a summative perspective on what it means for teachers to be designers. The publications provided a holistic view of how scholars characterize teachers as designers, including how, where, and what teachers design and trends in educational design research.

The four articles comprising this strand asserted teachers are designers; design is a core element of what teachers do. Kirschner (2015) claimed “expert teachers” are teachers as designers and practitioners combined: teachers gather information, analyze and diagnose problems, determine actions, carry out those actions, evaluate results, and adjust for future iterations. Svihla et al. (2015) emphasized that teachers design by responding to ongoing needs of the classroom, both before and during instruction. McKenney, Kali, Markauskaite, and Voogt (2015) discussed three strands of teacher design work: technical, focused on design processes and instructional planning; phenomenological, centered on improvisation and intuition; and realist, emphasizing design expertise and cognition as well as practical concerns. Viewing teachers as designers can also assist in classroom technology integration: teachers must design how they will use new (and old) technologies. Pre- and in-service teacher education that emphasizes the design aspects of teaching can lead to more effective implementation of new educational methods, including deliberate technology integration.

Pedagogical Design Capacity: Adapting Tools

Three publications were included in *Pedagogical Design Capacity*, a strand highlighting how teachers design by adapting learning tools or artifacts (including curriculum) to their local

context. The publications focused on how teachers adapt tools to meet student needs and the types of support teachers need to do so successfully. For example, Matuk, Inn, and Eylon (2015) discussed how characteristics of learning technologies can affect teachers' abilities to identify student needs and adapt instruction accordingly. Davis et al. (2011) highlighted the challenges of supporting teacher adaptations without losing the intent of the original design.

The literature in this strand cited Brown, a math educator who described the need for teachers to develop pedagogical design capacity (PDC). Brown (2011) defined PDC as "a teacher's capacity to perceive and mobilize existing resources in order to craft instructional episodes" (p. 29). Teachers with high PDC identify affordances in artifacts, make effective decisions for how to implement artifacts, and deliberately enact those decisions in practice. Teachers can design their instruction by making insertions, deletions, or substitutions to a curriculum or artifact before or during instruction (Davis et al., 2011). Decisions are based on the context; the teacher's understanding of student needs and strengths; the learning goals; and teacher's knowledge, beliefs, identities, and orientations (Davis et al., 2011). Additionally, teachers with high PDC design use based on the affordances of the tools themselves (Matuk et al., 2015). The PDC strand of teachers and design searched for methods to support teachers in adaptations. In particular, the research considered how to ensure adaptations align with the pedagogical goals of the original artifact.

Learning Design: Patterns for Learning

Learning Design is closely related to Laurillard's (2012) highly cited work on teaching as a design science. Although Laurillard did not use the term *learning design*, her work suggested that as a design science, the field of teaching needs to document, share, and evaluate models for learning. Eleven publications represented the learning design strand of research, including three books, one conference proceeding, one book chapter, and six journal articles. Publications exhibited three primary categories: overviews and descriptions of learning design (Conole, 2013; Laurillard, 2012; Mor & Craft, 2012; Mor, Craft, & Hernández-Leo, 2013; Mor, Mellar, Warburton,

& Winters, 2014), creating learning design patterns as part of professional development (Mor & Mogilevsky, 2013; Mor, Warburton, & Winters, 2012), and specific uses of learning design including incorporating learning analytics in the process of teacher inquiry (McKenney & Mor, 2015; Miao, Ally, Samaka, & Tsinakos, 2014; Mor, Ferguson, & Wasson, 2015; Perisco & Pozzi, 2015).

Learning design uses “design” as both a verb and a noun: to describe the process of creating environments that stimulate learning, and documentation and sharing of the resulting patterns. Research on the process of promoting learning includes techniques for helping teachers reflect on successful teaching experiences and identify the pedagogical patterns exhibited in those experiences (Mor, Warburton, & Winters, 2012). Then, teachers document the pattern in some form, externalizing the design for sharing and reflection. The products of the design experiences allow teachers’ pedagogical knowledge and beliefs to be made explicit. Beliefs and knowledge can then be shared, criticized, and adjusted to be more effective and efficient (Conole, 2013; McKenney & Mor, 2015; Mor, Craft, & Hernandez-Leo, 2013; Mor, Ferguson, & Wasson, 2015). The designs can be catalogued for sharing (Mor & Craft, 2012), resulting in a corpus of patterns, resources, tools, and activities for teaching and learning (Conole, 2013).

Collaborative Curriculum Design: Creating Curricular Reform Together

Like *Learning Design*, *Collaborative Curriculum Design* (CCD) focuses on teachers designing learning materials. However, CCD emphasizes teacher development through collaborative design processes, the design of subject-matter curriculum, and attempts at educational reform. Rather than create general principles and patterns for learning, teachers use CCD to create, adapt, and implement disciplinary-specific curriculum. The seven pieces grouped under CCD primarily consist of case studies of professional development. Additionally, Voogt et al. (2011) provided an analysis of nine case studies of teacher design teams. The case studies illustrated the benefits and challenges of CCD, teachers’ development of content and

technological knowledge throughout the process, and supports teachers need to effectively participate in CCD.

Three closely related terms, collaborative curriculum design (CDC), co-design, and teacher design teams were used in similar ways in the literature. Voogt et al. (2011) defined teacher design teams as “teams of at least two teachers who collaboratively design or (re)-design curriculum materials, with the aim of improving or changing their own instructional practice” (p. 1236). Similarly, Voogt et al. (2015) described collaborative curriculum design as design where “teachers create new or adapt existing curricular materials in teams to comply with the intentions of the curriculum designers and with their contexts” (p. 260). CCD includes evaluating options, defining problems, and making design decisions with others (Boschman et al., 2015). It can also involve consultation with subject-area or educational design experts (Voogt et al., 2011). The authors of the articles in this strand described CCD and teacher design teams as methods that promote and facilitate reform (Agyei & Voogt, 2012; Huizinga et al., 2014; Penuel & Gallagher, 2009; Voogt et al., 2011; Voogt et al., 2015). Giving teachers a central role in creating materials for curricular reform gives teachers opportunities to reflect on the goals of the reform, create materials that immediately bring new ideas into their classrooms, and assume ownership of reform. Furthermore, working with other teachers and external experts facilitates reflection on their personal knowledge, beliefs, practices, and goals, leading to the growth necessary for understanding and implementing new ideas (Agyei & Voogt, 2012; Boschman et al., 2014; Penuel & Gallagher, 2009; Voogt et al., 2011; Voogt et al., 2015). Thus, CCD is not only used to develop new curriculum materials, but also develops knowledge, skills, and beliefs, facilitating curricular reform.

Participatory Design: Making Sense Together

Where CCD focuses on teachers creating curriculum materials, *Participatory Design* emphasizes the process of engaging diverse stakeholders on a design project to disrupt historical power and social relationships. Six publications described participatory design in education.

Literature included descriptions and case studies of teacher's experiences with participatory design of computer software (Cober et al., 2015) and school buildings (Könings et al., 2017), the benefits and challenges of participatory building design (Woolner, 2010), and critical inquiry of power and roles of participants in participatory design work (Bang & Vossoughi, 2016; Severance et al., 2016).

Key elements of participatory design included involving a wide range of stakeholders (Bang & Vossoughi, 2016; Cober et al., 2015; Könings et al., 2017; Könings et al., 2014; Woolner, 2010), striving to understand the perspectives of others (Bang & Vossoughi, 2016; Cober et al., 2015, Könings et al., 2014), recognizing the value of knowledge and expertise from each stakeholder (Cober et al., 2015, Könings et al., 2014; Woolner, 2010), designing for the end user (Cober et al., 2015; Woolner, 2010), focusing on practice (Cober et al., 2015), and emphasizing the equal sharing of power across all stakeholders (Bang and Vossoughi, 2016; Severance et al., 2016). Cober et al. described two "guiding principles" of participatory design: (1) "quality improves because end users are involved in the design process" and (2) "democracy of participation is ensured in all aspects of the design" (p. 205). The emphasis on equal partnerships across participants is what sets this strand of design apart. Proponents argue that this results in more effective and appropriate designs.

Design Thinking: Design Epistemology

Design Thinking was the central theme of three of the articles and one book analyzed. In a book on design learning, Koh, Chai, Wong, and Hong (2015) described design thinking as thinking behind design approaches to solve problems and argued design thinking should be a core skill for both student and teacher learning. They cautioned that there is not a single definition that can explicate design thinking but described it as an intentional act to making things that improve the living environment and social structures. It employs a unique epistemology or way of learning. Rouzzouk and Shute (2012) provided their own definition of design thinking:

Design thinking refers to how designers see and how they consequently think. It is an iterative and interactive process where designers (a) see what is there in some representation of problem-solving concepts/ideas, (b) draw relations between ideas to solve the problem, and (c) view what has been drawn as informing further design efforts. (p. 334)

Burdick and Willis (2012) described design thinking as "interpretive, situated ways of knowing and understanding of the world from the perspective of another" (p. 555). Thus, it is a way of seeing, thinking, and knowing that is situated in context and bridges problems and solutions. Other core elements of design thinking included an iterative process (Burdick & Willis, 2012; Koh, Chai, Benjamin, & Wong, 2015; Koh, Chai, Wong, & Hong, 2015; Rouzzouk & Shute, 2012), human-centeredness (Burdick & Willis, 2012; Rouzzouk & Shute, 2012), and emphasis on active problem solving (Burdick & Willis, 2012; Koh, Chai, Benjamin, & Wong, 2015; Koh, Chai, Wong, & Hong, 2015; Rouzzouk & Shute, 2012). All authors noted that design thinking is a critical skill for both students and teachers; design thinking is a core element of pedagogical change for 21st century learning. In particular, Koh, Chai, Wong, and Hong (2015) argued a design epistemology helps teachers creatively and confidently adapt to the shifting learning needs of students.

Learning by Design: Designing Pedagogy

Learning by Design is a term used by Cope, Kalantzis, and Yelland to describe an approach to helping teachers develop effective pedagogy (or formalized learning) (Cope & Kalantzis, 2015). They described learning by design in a broad way; they defined the term as pedagogy, formalized learning, and a classification of activity types. More specifically, learning by design is the type of epistemological work behind reflexive pedagogy, a method focused on social learning through various knowledge building processes.

Yelland et al. (2008) described various parts of the learning by design framework. For example, it includes documentation of a learning elements and forming learning patterns, similar to the learning design patterns described by Mor et al. (2014) and Laurillard (2012). However,

unlike learning design, Yelland et al.'s learning elements included specific learning tasks or lessons, and designs centered on reflective pedagogy. The authors explained its main aim was to "examine and document the ways in which learning happens by design" (p. 199). The project resulted in templates and processes that can help teachers make pedagogical decisions explicit as they create and manage lesson plans and programs. For teachers, this means creating learning activities that address multiple knowledge processes and reflecting on the results. Teachers practice and develop professional knowledge through the design process.

Other: Variations on a Theme

Three articles did not fit clearly into the categories above, though each seemed to be a variation or theoretical extension of a strand. First, Holmberg (2014) called for a reflective approach to learning design, similar to Brown's pedagogical design capacity. Holmberg, however, placed this reflection in a research context: he proposed a flavor of design-based research that emphasized reflection on the practitioner's teaching practices. In other words, he claimed focusing on the development of an artefact, rather than focusing on the artefact itself, would improve research-practice connections and enable more effective transferability.

Two articles described "design for learning," though each conceptualized the construct differently. Hauge's (2014) work used "design for learning" to describe what happens in the classroom during learning time: the reflective design practices of teachers and students as they co-construct knowledge. Hauge paired "design for learning" with "design for teaching," or what teachers do before instructional time. He combined two prominent views on design: design as a reflective practice as described Schön, and design as technical rationality, akin to Simon's writing. Hauge presented a dialectic relationship between design for teaching (a primarily technical rational process of aligning activities and strategies for teaching a certain curriculum) and design for learning (reflective processes that occur during learning).

Goodyear and Dimitriadis (2013) also described a version of design for learning; however, they argued for a stricter definition of design that does not include pedagogical decision

making. They defined “design for learning” as creating things that help others learn and presented design as a method for addressing ongoing and complex issues in education. They claimed design needs to explicitly address the role of the teacher, what is being designed, and the activity the learners engage in. They emphasized designers cannot design learning; learners control engagement in the activity. Thus, design for learning addresses the tasks and physical and social architectures of learning on different levels of granularity, with special attention given to the extended lifecycle of design.

APPENDIX D

IRB APPROVAL LETTER

EXEMPTION
GRANTED

Punyashloke Mishra
Division of Educational Leadership and Innovation - Tempe
Dear Punyashloke
Mishra:

On 11/14/2019 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Creative Curriculum Design for Teachers
Investigator:	Punyashloke Mishra
IRB ID:	STUDY00011078
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• ConsentForm, Category: Consent Form; • CreativeCurriculumDesignProtocol, Category: IRBProtocol; • End Of Research Data Collection and Interview Protocol.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focusgroup questions); • Initial Interview Protocol.pdf, Category: Measures(Survey questions/Interview questions /interview guides/focus group questions); • Recruitment Script.pdf, Category: RecruitmentMaterials; • Warr IRB 6 Aug 19.pdf, Category: Off-site authorizations (school permission, other IRBapprovals, Tribal permission etc); • Workshop Outline.pdf, Category: Other;

The IRB determined that the protocol is considered exempt pursuant to
FederalRegulations 45CFR46 on 11/14/2019
In conducting this protocol you are required to follow the requirements
listed in the INVESTIGATOR MANUAL (HRP-103).
Sincerely,

IRB

Administrator

cc: Melissa Warr

APPENDIX E

PREVIOUS PUBLICATION AND CO-AUTHOR PERMISSION FOR USE

Chapter two of this work consists of an article previously published in the Journal of Teaching and Teaching Education in March 2021:

Warr, M., & Mishra, P. (2021). Integrating the discourse on teachers and design: An analysis of ten years of scholarship. *Journal of Teaching and Teacher Education*, *99*(March 2021). https://doi.org/10.1016/j.tate.2020.103274

Dr. Punya Mishra, the second author of the article, has given permission for inclusion of the article in this dissertation.