Research paper

Integrating the discourse on teachers and design: An analysis of ten years of scholarship☆

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HIGHLIGHTS

- We analyzed ten years of highly-cited scholarship on teachers and design.
- A content analysis resulted in 10 strands of work around teachers and design.
- Co-authorship and citation network analyses provided a more nuanced perspective.
- Each strand presented what, who, when, and why teachers design in different ways.
- Viewing teaching as a design profession can enable new directions for teacher education research and practice.

ARTICLE INFO

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.

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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, Brand-Gruwel, & van Merriënboer, 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 teachers'

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, Penuel, Sumner, & Leary, 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, Pozzi, and Goodyear (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

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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, McKenney, and Sagy (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.

1. 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, Warwick, Vermunt, Mercer, & Van Halem, 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).

2. 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, Kleinsasser, & Roe, 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 (Penuel, Fishman, Cheng, & Sabelli, 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, Beyer, Forbes, & Stevens, 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 (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, Chai, Benjamin, & Hong, 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, Chai, Wong, & Hong, 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.

3. 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?

4. 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, Reger, & Pfarrer, 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, Gašević, Siemens, & Joksimovic, 2014, pp. 231−240; 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 cited could be considered nodes, with edges connecting the publication with the authors it cited (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, Wiggins, & Goodreau, 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, van Eck, &

Wouters, 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.

5. 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, Sutton, & Papaioannou, 2016) to identify databases and search terms that would best retrieve relevant literature. We identified four articles (Jordan, 2016; Kali et al., 2015; Könings, Seidel, & van Merriënboer, 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 to 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 Fig. 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 Fig. 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.

6. 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
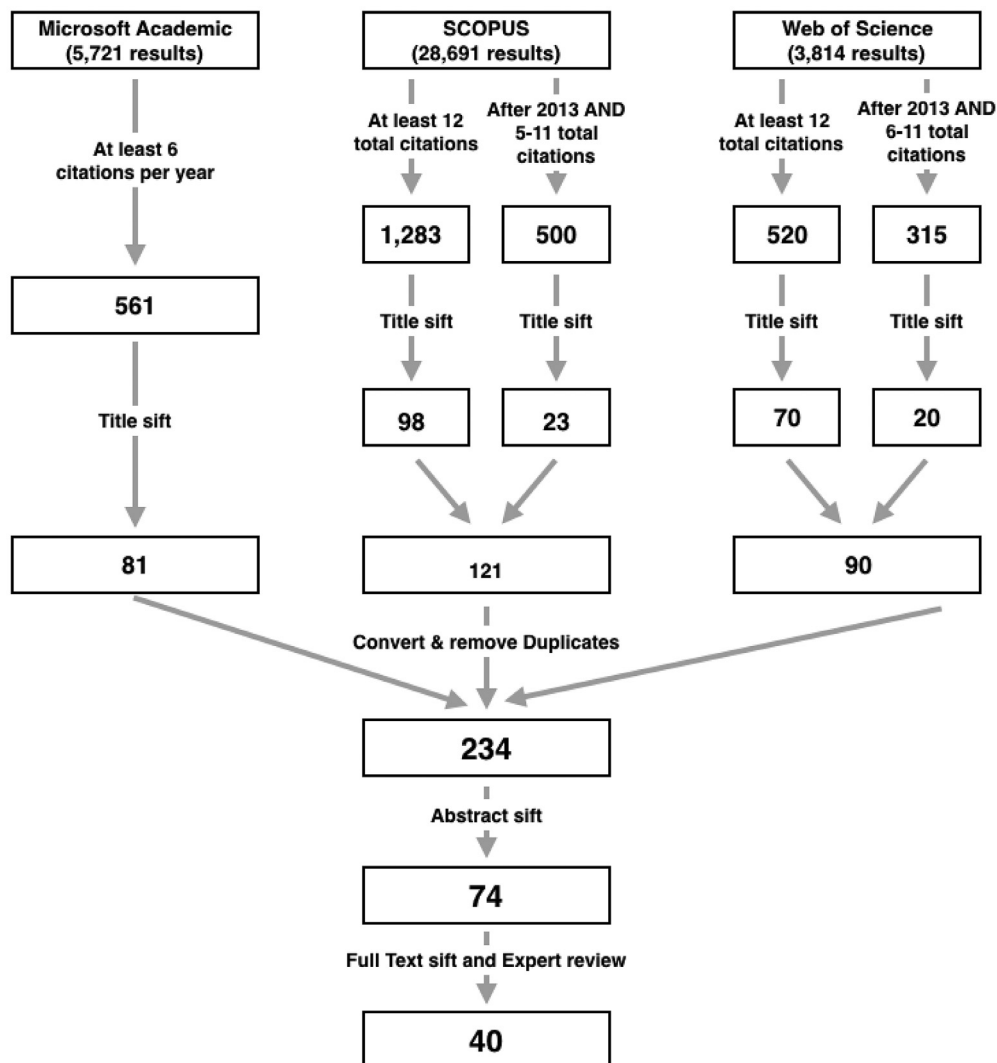

Fig. 1. Process for article selection. Counts represent number of publications included in each selection stage.

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, McKenney, and Voogt (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 (Hauge, 2014; Holmberg, 2014; Yelland, Cope, & Kalantzis, 2008). 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 (2010), 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.

7. 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.

8. 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?").

8.1. 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.

Fig. 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.

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
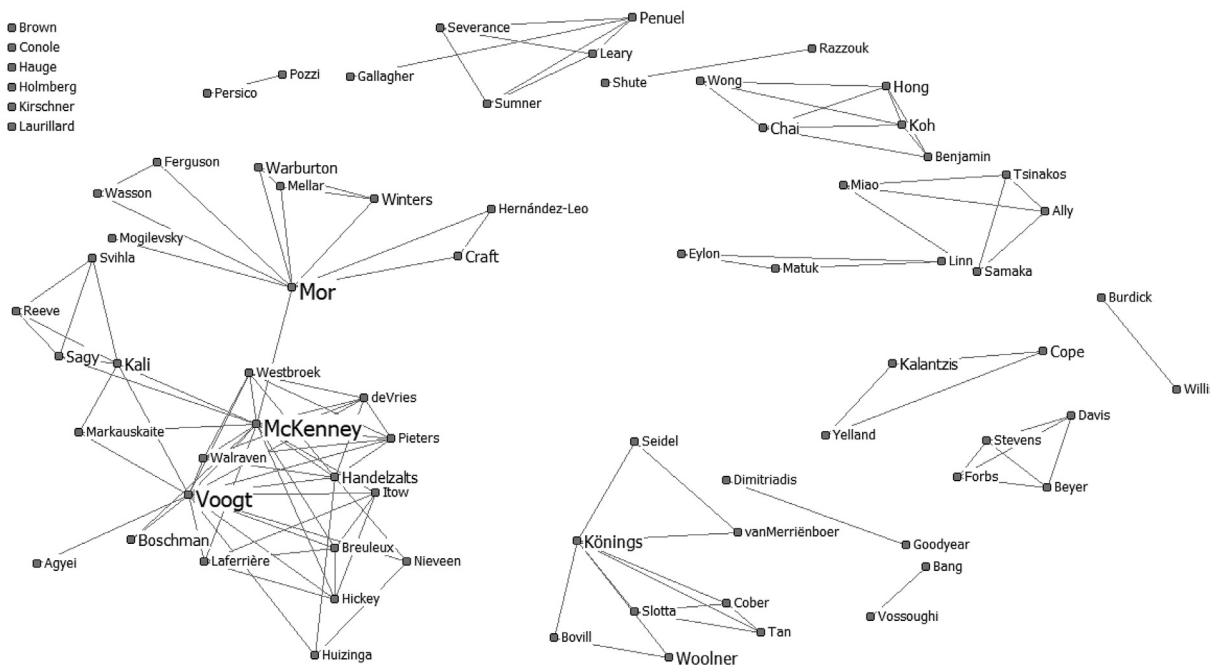
Fig. 2. Co-authorship network analysis map created with Gephi (2017) spring embedding layout (based on similarities of geodesic distance and edge length). Although the location of each unique cluster is arbitrary, distances within clusters reflect connection strength. Size of author names reflects the number of publications by each author in the analyzed literature.

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.

Fig. 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.

8.2. 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 common in academic literature. 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.

Fig. 4 maps each publication to the scholars cited. This process resulted in 3953 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 Fig. 4, although the algorithm, and thus the spatial placement of each publication, reflect all 3953 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 (2015) 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 Fig. 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, Fig. 4 demonstrates cluster relationships and overlaps. Most notably, *Pedagogical Design Capacity* publications overlap *Participatory Design*, *Collaborative Curriculum*

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	; Kirschner, 2015; McKenney et al., 2015; Svihla, Reeve, Sagy, & Kali, 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 and Mor, 2015 ; Miao, Ally, Samaka, & Tsinakos, 2014; Mor & Craft, 2012; Mor, Craft, & Hernández-Leo, 2013; Mor, Ferguson, & Wasson, 2015; Mor, Mellar, Warburton, & Winters, 2014; Mor & Mogilevsky, 2013; Mor, Warburton, & Winters, 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, McKenney, & Voogt, 2015; Huizinga, Handelzalts, Nieveen, & Voogt, 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, Tan, Slotta, So, & Könings, 2015; Könings, Bovill, & Woolner, 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, Linn, & Eylon, 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)
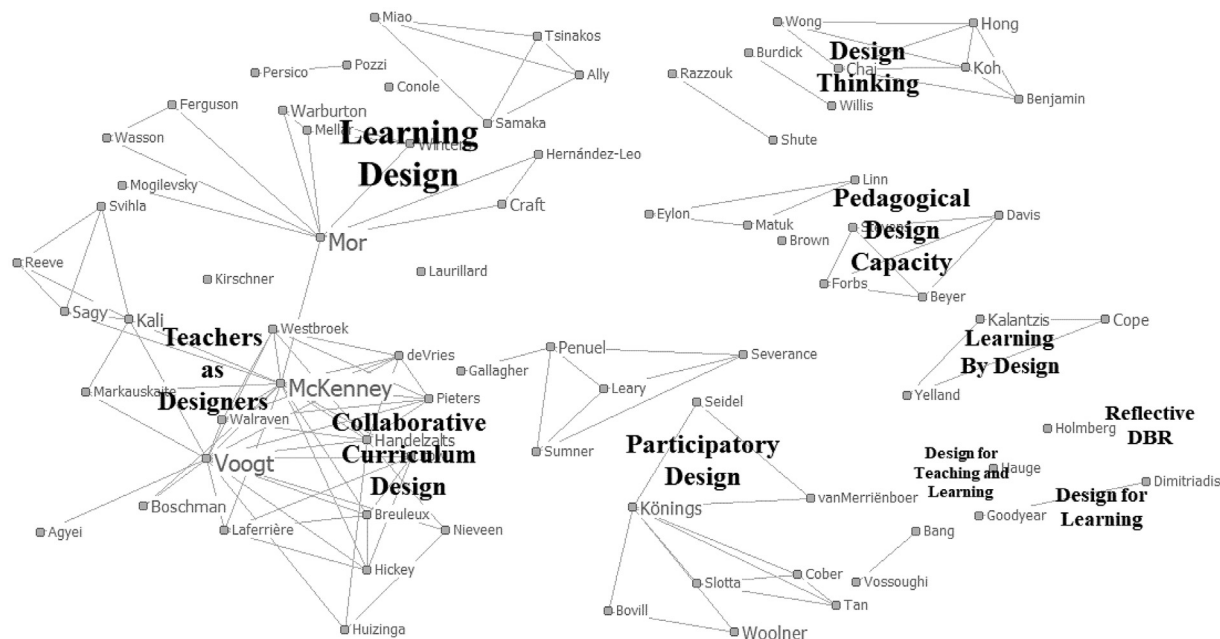
Fig. 3. Co-author network map with strand name overlap. Single-node clusters were manually positioned next to strand identified through content analysis. Size of text reflects number of publications by author and strand.

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.

Fig. 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 and Willis, 2011; Razzouk & Shute, 2012) focused on general design thinking skill development.

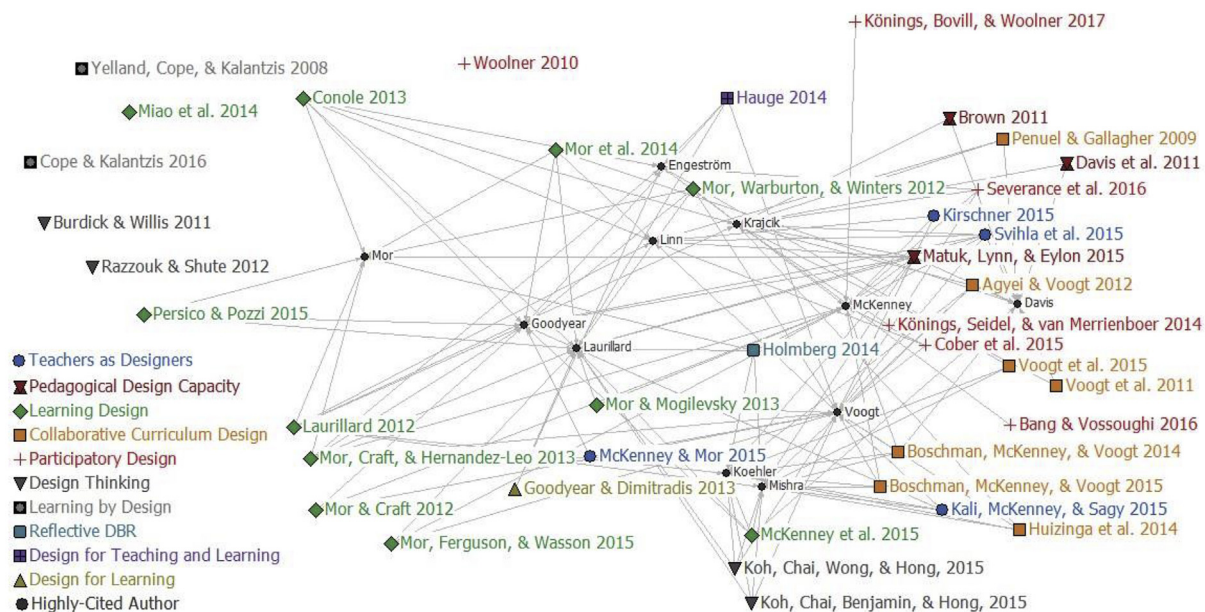**Connecting scholars.** In addition to showing the relationships

Fig. 4. Citation network analysis map 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.
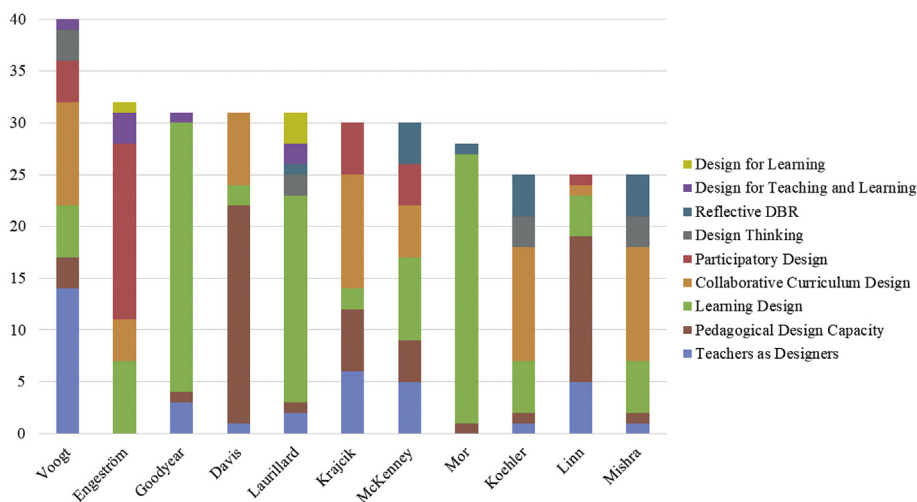

Fig. 5. Citations by strand for the most cited scholars. Self-citations were removed before analysis.

among strands, the citation network map in Fig. 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. Fig. 5 provides additional detail on 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 of

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 Fig. 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, Soloway, & Marx, 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.

8.3. 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.

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 Fig. 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.*

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.

9. 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 (Fig. 4) as well as explored the citation patterns of highly cited scholars (Fig. 5) to identify two core groups: (1) *Learning Design* on the left of Fig. 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,

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
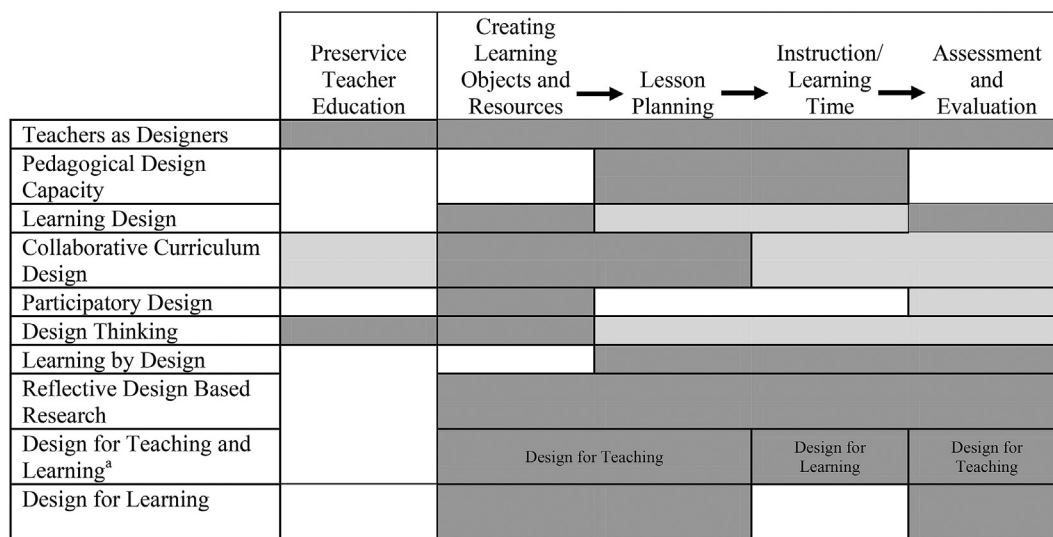
Fig. 6. Illustration of each strand's description of when teachers design. Dark shaded boxes indicate emphasis of strand. Lightly shaded boxes highlight time periods when design practices may also occur according to the strand literature. [a]Hauge (2014) separated "design for teaching" from "design for 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.

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. Fig. 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 (2013) 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.

10. 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 Method 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.

11. 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.

Ethical standards

This article does not contain any studies with human participants or animals performed by any of the authors.

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Declaration of competing interest

The authors declare no potential conflicts of interest with respect to the research or authorship of this article.

Appendices A-C. Supplementary data

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