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Designing theory

Melissa Warr[1] · **Punya Mishra**[1] · **Ben Scragg**[1]

Abstract
Theoretical work is essential to the progress of any discipline. Theories, models, and frameworks are underdetermined representations of a phenomenon that help us understand and take action in a domain. However, the field of learning design and technology (LDT) has traditionally struggled with developing a solid theoretical foundation that is useful for both research and practice. We propose viewing theory building as an act of design might address these challenges. After defining key constructs and describing two approaches to theory development, we describe three design perspectives that might be useful for theory development: Lawson and Dorst's (Design expertise, Elsevier, Amsterdam, 2009) view of design as a combination of analytical (problem-based) and creative (solution-based) moves, Schön's (The reflective practitioner: how professionals think in action, Basic Books, New York, 1983) reflection-in-action, and design as dialogic interpretation (Snodgrass and Coyne in Des Issues 9(1):56–74, https://doi.org/10.2307/1511599, 1992). We use a case study to illustrate each perspective. We conclude with implications of a design approach to theory creation, including how design perspectives enable scholars to design possible futures.

Keywords Theory development · Design · Design thinking · TPACK · Community of practice

> When a man desires ardently to know the truth, his first effort will be to imagine what that truth can be. He cannot prosecute his pursuit long without finding that imagination unbridled is sure to carry him off the track. Yet nevertheless, it remains true that there is, after all, nothing but imagination that can ever supply him an inkling of the truth. He can stare stupidly at phenomena; but in the absence of imagination they will not connect themselves together in any rational way.
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> —Peirce (CP 1.46, c. 1931)

Theoretical work is central to progress in any discipline: it provides a foundation, a way for scholars to communicate and build off one another, and new perspectives and ideas. However, the field of learning design and technology (LDT) has struggled with theory,

✉ Melissa Warr
mcwarr@asu.edu

[1] Mary Lou Fulton Teachers College, Arizona State University, Farmer Building, Mail Code 1811, Tempe, AZ 85287, USA

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both in the research and practice sphere. In this article, we propose that applying design perspectives to theory development might lead to more effective theory development in LDT. Rather than viewing theory as something that appears directly from empirical data, we argue that, to some extent, scholars create theory, and that viewing theory development as an act of design might lead to a stronger theoretical and practical scholarship in LDT. In particular, a design perspective on theory has the potential to address several challenges for theory development in LDT, which we outline next.

Theory development and application has proved challenging for LDT. First, scholars have noted the lack of theoretical base for much research in LDT (including information and communications technology (ICT), educational technology, and technology integration), resulting in scholarship without a common base or language and limiting growth in the field. Over a decade ago, Underwood (2004) and McDougall and Jones (2006) called for more attention to theoretical development in ICT literature, particularly with regards to the need to build on one another's scholarship. A particular challenge in ICT concerns rapid changes in technological tools. Consequently, research tends to focus on justifying the use of new technologies rather than building theory (McDougall and Jones 2006). More recently, scholars have questioned whether the educational technology field has adequately addressed these issues. Graham et al. (2013) reiterated the concern for a lack of theoretical roots in educational technology, though progress seems to have been made through the technological pedagogical content knowledge (TPACK) model (Mishra and Koehler 2006) and several theoretical frameworks in distance education (e.g. transactional distance, Moore 2013; community of inquiry, Garrison et al. 2010). Similarly, Antonenko (2015) described a lack of attention to conceptual frameworks, including inadequate use and development of theory, in educational technology literature. Finally, Hammond and Alotaibi (2017) discussed theoretical limitations of the research on technology integration.

A second limitation of theoretical work in LDT concerns the disconnect between theory and practice. For example, Yanchar et al. (2010) interviewed instructional designers to better understand the role of theory in their design work. They found that although designers seemed to value theory and attempted to use it for decision making, sense-making, and to justify design decisions, they struggled with many theories that were abstract and difficult to apply. The authors suggested that perhaps some theory is too disconnected from practice to be useful to designers. Similarly, Hammond and Alotaibi (2017) described a weak connection between technology integration theory and practice: theorizing tends to consist of lists of factors or influences on integration instead of the larger concepts of the socio-cultural-physical space within which integration occurs. The results are theories that neglect central elements of school contexts, such as constraints on teacher choice and physical arrangement of technology. The theories have limited practical value.

We argue that two characteristics of LDT make theorizing particularly challenging. First, the domain of LDT has some inherent complexity and uncertainty. Borko et al. (2009) drew on Rittel and Webber's (1973) descriptions of "wicked" problems to discuss challenges in educational technology. Wicked problems are complex, dynamic problems that are contextually bound; contain many interdependent variables; and may even differ depending on stakeholder perspective. Borko et al. pointed out a range of characteristics that suggest that the field of LDT is wicked. These include: instability (characterized by a rapid pace of development and a constantly shifting knowledge base); unreliability (new tools and approaches are implemented before they have been fully tested), contextual dependence (dependence on financial and intellectual resources); and unpredictability of outcomes (technological advances have complex social and psychological implications). Additionally, LDT is inherently interdisciplinary, bridging psychology, technology,

design, research, practice, and more. Theorizing in LDT requires consideration of many, if not all, of these disciplines simultaneously, further complicating the process of theory development.

A second challenge of theorizing in LDT is the need for close connections between theory and practice. For theory to play a significant role in LDT, it must not only put forth fact-based claims but also provide guidance for design and policy. This challenge harkens back to Yanchar et al.'s (2010) findings that instructional designers find much theoretical work too abstract to afford practical application.

Addressing the limitations of theory in LDT with design perspectives

In this article, we suggest design perspectives might support stronger and more applicable theory in LDT. A perspective provides a way of viewing or framing a phenomenon that not only affects how we perceive a situation but also reveals action possibilities (see Dall'Alba 2009). In this sense, perspectives are not necessarily right or wrong, but rather provide value by revealing aspects of a phenomenon that may not have been salient otherwise. In this article, we use the term design perspectives to describe ways designers and design theorists view and act in situations. We assert design perspectives provide a way to address the particular challenges of theorizing in LDT: design supports work in wicked contexts, and design couples theory and practice.

First, Buchanan (1992) argued that design is particularly suited to working in wicked contexts. He defined design as a liberal art that "connect[s] and integrate[s] useful knowledge from the arts and sciences… in ways that are suited to the problems and purposes of the present" (p. 6). Goel and Pirolli (1992) also described characteristics of domains that are often approached through design rather than general problem-solving strategies. They described key characteristics of design spaces:

- Designers begin with an incomplete understanding of, and information about the problem, the end goal, and the right ways to move from problem to goal.
- There are no fixed rules for how to precede.
- The problem includes multiple constraints, including social, political, legal, and economic constraints.
- There are no right or wrong answers, just better or worse solutions.
- The problem space contains many parts in "contingent interconnections" (Goel and Pirolli 1992, p. 402).

We argue that the characteristics wicked contexts as described by Rittel and Webber (1973), and of design spaces described by Goel and Pirolli (1992; see also Boling and Smith 2012), capture some essential characteristics of the LDT domain. Thus, viewing theory development as an act of design might address some of the limitations of theoretical work in the field.

Second, the need to tightly link theory and practice is also seen in design fields, where scholars attempt to simultaneously "embrace values of design and science" (Beck and Stolterman 2016, p. 210). As a consequence, theorizing in design research can look different from theoretical work in science-based fields. Beck and Stolterman (2016) described how design researchers often make multiple types of knowledge claims. Rather than only making fact-based claims, design researchers also make claims of policy, value, concept,

and interpretation. Beck and Stolterman suggested this might be because of the need for relevance to multiple audiences—multiple disciplines as well as both practitioners and researchers. LDT faces a similar challenge; it must build theory that is useful to both researchers and practitioners, and that can span multiple disciplines. Once again, drawing upon design perspectives might enable more effective theoretical work in LDT.

The purpose of this article is to explore how design perspectives can reveal new possibilities for theoretical work in LDT. We suggest design perspectives may help LDT scholars navigate complexity and couple theory building and practice, and viewing theory building as an act of design could lead to a more solid and actionable theoretical foundation. We also strive to de-mystify the theory building process by demonstrating how it can become embedded in everyday research and practice, resulting in not only a stronger theoretical base, but theory that is deeply intertwined with the concerns and pragmatics of practice.

We build our argument as follows. We lay the foundation for our argument by clarifying what we mean by theory and design. We suggest criteria for evaluating theory and describe two approaches to theory development, then offer three perspectives on design (either as being a combination of analytical and creative moves, a process of reflection-in-action, or a hermeneutic-inspired dialogic interpretation). Next, we bring together theory and design perspectives through three illustrative case studies in order to demonstrate what design perspectives of theory might look like and how they can result in impactful theory. We conclude with implications for design perspectives on theory development, including how designing theory is ultimately about designing possible futures.

Theory and theory building

Before addressing how we can view theory building from design perspectives, we must clarify what we mean by theory and describe current approaches to theory building. In this section, we define models, theories, and frameworks; compare two approaches to theory development; and suggest criteria for effective theory in LDT. First, however, it is important to note that, although in this article we focus on the development of scientific theories and frameworks through design, we acknowledge that our field supports a variety of approaches and descriptions of knowledge and knowledge building. For example, professional designers have been described as having different ways of knowing and types of knowledge (Gregor and Jones 2007; Löwgren 2013) and design itself can be considered an epistemology (Lawson and Dorst 2009). For example, Elizabeth Boling has led extensive research into the importance of case-based knowledge (precedent) to the instructional design field (e.g., Boling and Gray 2018; Boling et al. 2015). Furthermore, a "design theory" provides a different type of knowing than traditional scientific theory. Design theory moves beyond description to how to actually *do* something (Baskerville and Pries-Heje 2010; Gregor and Jones 2007; Lee et al. 2011). These types of theories and stores of knowledge are critical to design practice itself and should continue to be developed within the instructional design field. However, here we turn our attention to a different relationship between design and theory: we consider what design *perspectives* can offer the for the development of scientific theory in both instructional design and the broader LDT field.

Defining models, theories, and frameworks

Researchers and scholars often use the words theories, models, and frameworks interchangeably, so it is important to lay out what *we* mean by these terms. In this paper, we define a model as a casual representation of a phenomenon. A model highlights causal relationships through descriptions or representations of select elements. For example, a model of the solar system demonstrates how the planets rotate around the sun in particular ways. A model including the sun, planets, and their rotational and orbital paths might be used to explain the changes of temperature of planets. Other elements—such as moons—might be included if the goal is to illustrate the impact of tidal forces on planets and their orbits. A framework is a representation that does not necessarily include causal relationships. For example, a framework might be a taxonomy or a diagram mapping out relationships between concepts.

Theories, on the other hand, are explanatory mechanisms. In other words, a theory can be considered to be a model that utilizes some hidden variable(s) or construct(s) in order to explain the phenomena in question. In order to develop a theory, the scientist must make a creative leap to explicate hidden components. For instance, in the example above, the hidden construct that can help explain planetary phenomena may be Newton's universal theory of gravitation. Similarly, in the kinetic theory of gas, molecules (often visualized as idealized, perfectly bouncy spheres) bump up against each other to create various observable phenomena such as temperatures and pressures and the relationships between them. The balls represent a hidden variable—an aspect of the phenomenon that we infer but can't observe directly. A similar example can be found in cognitive psychology where a hidden construct such as a schema can be used to explain ways in which our memory works.

Another aspect of theory, as first described by Popper (2002), is that it is impossible to prove. We can *disprove* theories by observation or experimentation, but they can never be proved. In fact, according to Popper, falsifiability is a key defining characteristic of a scientific theory.

That said, falsifiability has always been somewhat difficult to define, even in the (so-called) hard sciences. Scientists are often hesitant to change their theories, even when faced with contradictory information. The history of science shows that scientists often come up with tweaks to their original theories rather than change them. In the sciences, however, the data against an old theory and/or for a new theory can become overwhelming, leading to overturning the old theory. In other cases, the new theory offers a more elegant, parsimonious explanation of the phenomena in question. For instance, it is possible, even today to consider the earth as being the center of the solar system, though the mathematical calculations required to keep that perspective are highly complicated.

All these issues (the conservatism of scientists, the ability to develop ancillary hypotheses) exist in the spaces of social science. Further complicating issues of disproving social science theories is that in the social sciences, dealing as they do with human beings, it is difficult to establish strong causal relationships between variables. Thus, theories in the social sciences need to be conceptualized in a different way. As Wenger-Trayner (2013) wrote:

> A theory in the social sciences is not a statement of truth that can be verified or falsified. The notion of community of practice, for instance, is not true or false. It is a way of thinking about the social nature of the negotiation of competence. A theory in this sense is a framework that provides more or less useful ways of seeing the world. It allows one to tell certain stories. It enables one to know the world anew by focusing

> on new aspects, asking new questions, and seeking new observations and interpretations. Whether this counts as producing knowledge is a matter of definition; but it certainly contributes to our ability to make sense of the world. (p. 2)

Thus, in Wenger-Trayner's view, the goal of theory in social sciences is to provide insight, not necessarily to prove or disprove our interpretations. For example, the community of practice framework (Lave and Wenger 1991; Wenger 1999), that we describe in greater detail below, provides a perspective on how individuals come to identify with and become part of a professional community. The idea of community of practice cannot be proved or disproved (at least not in any sensible sense in which we use the words prove or disprove), but it does provide a useful perspective on the social processes of learning and can inform the design of learning spaces and experiences.

Two approaches to theory development

Understanding the role of theory and the fact that developing theory in LDT is complicated does not address the question of *how* we develop theories in the first place. Before describing design perspectives on theory, we consider two extant approaches to theory development: an *analytical-leaning approach* described by Whetten (1989) and an *interpretive-leaning approach* described by Wenger-Trayner (2013). Each describes elements of a theory, the criteria for effective theory, and the theory building process in a slightly different way. We will later show how combining these approaches can establish our first design perspective on theory development.

Whetten (1989) identified four essential elements or "building blocks" of theories: (a) what, the variables, constructs, or concepts to be included; (b) how, the relationship between the elements; (c) why, what holds the theory together (based on logical propositions); and (d) who, where, and when, the conditions in which the theory holds. Whetten noted that the who, where, and when are developed by testing the theory in different contexts, thus identifying theoretical limits.

Whetten (1989) described the theory building process as building a logic, or the "why," that holds together empirical observations (the what and how as observed in qualitative or quantitative data). Of the logical process, he described, "During the theory-development process, logic replaces data as the basis for evaluation. Theorists must convince others that their propositions make sense if they hope to have an impact on the practice of research" (p. 491). In a theory, the logic (which Whetten describes as "glue") has not been empirically verified. However, during the process of developing the "what, where, and when," limits of the theory are explored and tested. For Whetten, theory building is an evolutionary process of building a model through logic, testing it in different conditions, and revising the theory according to the results.

What, according to Whetten, makes a solid theoretical contribution? He described several criteria of theoretical contributions that might also apply to theory in general. First, a theoretical contribution must "marshal compelling evidence," (p. 493), whether that be logical, empirical, or epistemological. Next, the theory should demonstrate a clarity of expression, including a balance of parsimony (the number and complexity of elements and relationships) and comprehensiveness. He explained, "Sensitivity to the competing virtues of parsimony and comprehensiveness is the hallmark of a good theorist" (p. 490). Other criteria for theoretical contributions include the impact of the theory on research, timeliness of the theory, and relevance to the field of study.

Wenger-Trayner's (2013) writing on theory development provide a more interpretive perspective. Both Whetten (1989) and Wenger-Trayner described theory as something that is not (yet) proven, or that cannot be completely proven. However, where Whetten emphasized a logical process of developing explanations of the relationships that are to some extent observed through empirical research, Wenger-Trayner highlighted theory's role in providing new perspectives on a phenomenon. He explained, "Social theory aims to organize a perspective on the world rather than generate statements that can be true or false" (p. 1). He proceeded by explaining the relationships among theories not as a linear progression but rather coexisting perspectives that form "a puzzle of interacting pieces" (p. 1). Thus, for Wenger-Trayner, theory development should focus on providing a new perspective on a phenomenon, a perspective that expands potential for interaction.

Wenger-Trayner (2013) described parts of a theory as a group of technical terms and the relationships among the terms. Such a perspective is similar to Whetten's description of the what, how, and why embedded in theory. However, by focusing on language, Wenger-Trayner emphasized the communicative and rhetorical aspects of theory. Wenger-Trayner stated, "The art of theorizing has to do with choosing a collection of technical terms that are both precise and evocative and form a coherent whole" (p. 3). His criteria for effective theory included being generative (the theory suggests a new direction for research and action), evocative (it expands a perspective), recognizable (it resonates with our experiences in the world and empirical research), and systematic (is "rooted in a systematic discipline of language" (p. 3)).

Judging theory

Designers combine elements in a way that is better or more effective than previous methods, and, if we are to design theory, it is important to outline the elements of theory and criteria for evaluating them. We draw on both Whetten (1989) and Wenger-Trayner (2013) to do so. A theory is made up of constructs (the *stuff*) and the relationships among them. The stuff consists of things we observe in the world—whether through scientific research or through our own experiences. Like Whetten, we define relationships as what holds the stuff together, or the glue. We agree with Wenger-Trayner that we should strive for clarity in the terms we use to describe the elements of a theory.

We propose three broad criteria for judging theory. The first criterion is *fit*. A theory should describe what we are seeing and match empirical evidence. A theory must also be *actionable*. This implies the theory is predictive—it can be used to predict the outcome of some interaction. Actionable also means the theory expands perspectives, leading to new ways of understanding and engaging with the world. Finally, a theory must be *whole*. Wholeness, drawing on both Whetten (1989) and Wenger-Trayner (2013), is the degree to which a theory balances completeness and parsimony. This means that the number and complexity of the constructs and relationships should be detailed enough to make the theory comprehensive while at the same avoiding unnecessary complexity. Wholeness, as per Wenger-Trayner, also speaks to the "evocative power" (p. 3) of theory. He described, "Overly restrictive definitions can reduce the evocative power provided by the vernacular origin of terms. A tightly systematic theory can sometimes lose evocative power. A theory needs to strike a balance" (p. 3). In other words, while theorists should carefully define technical terms and constructs, definitions that are too narrow or esoteric will limit the theory's applicability and communicative value.

All three criteria, fit, actionability, and wholeness (balancing completeness and parsimony, and restrictiveness and evocative power), relate to what psychologist McGilchrist described a gestalt:

> Does this gestalt, which is an overall appreciation of a whole rather than nit-picking at little details—does this, generally speaking, answer better to the picture of reality I have? And does it answer some questions that were not answered under the old model? So that is a perfectly good question to ask. (Vedantam et al. 2019)

By developing a gestalt, the theorist influences how well the theory communicates ideas, promotes new perspectives, and affects practice. But in a complex, practice-focused field like LDT, how to we develop this gestalt? We suggest design perspectives may support the development of theory in LDT that demonstrate high levels of fit, actionability, and wholeness.

Understanding design

In the previous section, we defined theory as well as described what they are made of and presented criteria for judging theory. Next, we turn to the other construct central to our argument: design. Definitions of design abound. Rather than being a weakness of design, recognizing the multiplicity in design respects its complexity and opens space for change. Redström (2017) eloquently described:

> That we do not settle for just one definition of design is not because we do not understand the essence of design, but because it is much more powerful to work with difference as a basis when coping with complexity and change. And to work on the basis of (making a) difference, we need alternatives, and we need diversity. This is still a conversation between us about what design is, but it is one centered on its potentials for change, not its eventual convergence. (p. 141)

Design can be both be a verb (the act of designing) as well as a noun (the end product of the design process). As a verb, design can be thought of as *an intentional act of moving from what is to what is preferred,* or as Simon (1969) famously described, as devising "courses of action aimed at changing existing situations into preferred ones" (p. 111). If used as a noun, design can be considered a "structure adapted to a purpose" (Perkins 2013, p. 2).

There are many ways to conceptualize both the verb and noun form of design. Schön (1992) built on Dewey's pragmatism and emphasized the social and transactional aspects of acts of design when he described design as an *epistemology based on uniting theory and action.* Similarly, Lawson and Dorst (2009) and Pendleton-Jullian and Brown (2018) suggested that the designer begins with common sense and through acts of design can develop knowledge. In these examples, design is having a conversation with the situation—taking action and reflecting on the results. The reflection leads to the next action and creates new possibilities, new ideas, and new learnings; it results in outcomes adapted to a purpose (designs). Thus, design is an active way of exploring what could be; design is imagining possibilities, leading to new understanding of what is. A design is something created in a context for some purpose.

A related approach towards design is derived from hermeneutic philosophy (Jahnke 2012; Snodgrass and Coyne 1992, 1996) and focuses on the act and experience of design.

This perspective places more emphasis on the role of the designer. Central to this argument is how design is dialogic, works within complexity, and describes interaction between whole and parts. Though consistent with Schön's (1983) conceptualization of reflection-in-action, a hermeneutic perspective takes design a step further by emphasizing the role of the designer as an interpreter who brings their own contexts and beliefs to the design space. This perspective also reduces the subject-object duality existing in much of design discourse and recognizes that not all design spaces are "problems," but rather are spaces for interpretation. In each of these descriptions, what is common is that designers move through complex spaces, with changing parts, engaged in a dialogue with the evolving design even while reflecting on the impact on the whole.

In describing the outcome of the process of design (the design in noun form), Lawson and Dorst (2009) suggested that the final design should be an integrated, coherent whole that is unified and "free from inner contradictions and can be perceived as a whole; a single entity" (p. 44) giving "the feeling that everything has been taken into consideration, and is as it should be" (p. 44).

In conclusion, our discussion of theory development finds value in design as both a verb and a noun. We are interested in *how* theories are designed (the verb) as well as *what* theory emerges (the noun). We see the theory development process as being a complex, dialogic process of interpretation. Theory development balances contradictory needs through analysis and creativity, leading to a product that demonstrates fit, actionability, and wholeness and is suited to some purpose.

Designing theory: three perspectives

> Theorists often write trivial theories because their process of theory construction is hemmed in by methodological strictures that favor validation rather than usefulness (Lindblom 1987, p. 512). These strictures weaken theorizing because they de-emphasize the contribution that imagination, representation, and selection make to the process, and they diminish the importance of alternative theorizing activities such as mapping, conceptual development, and speculative thought.
>
> —Weick 1989, p. 516

A key argument in this paper is that viewing theory building from design perspectives can help the field of LDT build a more solid and impactful theoretical base. We have discussed what we mean by theory and design, and now we put them together by explaining three perspectives on designing theory, each with a corresponding case study (see Table 1). We hope inclusion of these cases not only highlights design perspectives and how they can lead to impactful theory, but also provides insight into the practicalities and situated nature of theory development.

Designing theory as analytical and creative moves: community of practice

> Inspector Gregory, to whom the case has been committed, is an extremely competent officer. Were he but gifted with imagination he might rise to great heights in his profession.
>
> —Sherlock Holmes to Watson
> Sir Arthur Conan Doyle 1893, p. 8

Table 1 Three design perspectives on theory development

Design perspective	Case example	Implications
Analytical + creative moves (Lawson and Dorst 2009)	Communities of Practice	Designing theory means combining empirical (analytical) research with creating new ideas and refining the theory based on the results
Reflection-in-action (Schön 1983, 1992)	Technological, Pedagogical, and Content Knowledge (TPACK)	Designing theory means interacting with a phenomenon or representation. Interaction increases understanding of the phenomenon and provides information for refining the theory
Dialogic interpretation (Jahnke 2012, Snodgrass and Coyne 1992)	The Five Spaces for Design in Education	Designing theory means creating new meaning through exploration, interaction, and interpretation. This might include "poetic redescription" (Jahnke 2012, p. 38) through metaphor

As Simon (1969) stated, the core of design is intentional movement from what is to what could be. As it applies to theory, *what is* is our current understanding of a specific phenomenon. *What could be* is a new way to understand that phenomenon—one that better meets our criteria of fit, actionability, and wholeness. Lawson and Dorst (2009) described design as a combination of analysis and creativity. Thus, we might envision the movement from what is to what is preferred through two types of moves: analytical (problem-focused) moves, and creative (solution-focused) moves. Each move is performed with reference to the phenomenon of interest (see Fig. 1). Analytical moves include exploring evidence through quantitative or qualitative research and logic. However, as both Whetten (1989) and Wenger-Trayner (2013) described, theory must go beyond direct observation. This is where creativity is required—theorists must generate tentative solutions that might suggest something new about the phenomenon. The tentative solution can then be investigated through further analytical work.

One way to envision the process of moving between problem and solution with analytic and creative moves is to consider Sir Conan Doyle's beloved detective Sherlock Holmes. Sherlock combines analysis and imagination to solve mysteries. For example, when asked if he has found a "solution" to a mystery, he is known to have responded "seven" or "three," meaning he is able to imagine seven (or three) solutions that fit the available evidence. After further investigation, possibilities narrow until only one answer remains. Pendleton-Jullian and Brown (2018) described, "[Sherlock's] imagination leads, and the reasoning does the cleanup" (p. 394). For Sherlock, finding answers requires imagining possibilities combined with careful analysis of the problem. This interplay of imagination and reason fits with what Dorst (2011) has called the "core" of design thinking: abductive reasoning about what could be.

Of course, Sherlock is looking for a singular and existing solution. Theorists, on the other hand, are attempting to create an actionable perspective on an unknown phenomenon. This requires going beyond the evidence to *make* a coherent picture. Thus, designing theory requires not just imagination, but creativity—actually creating a new perspective that is useful.

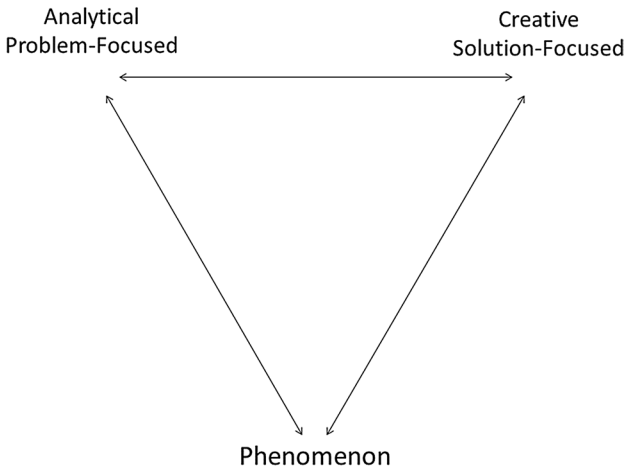

Fig. 1 A model of designing theory as a combination of analytical and creative moves

Wenger-Trayner's descriptions of the development of the community of practice framework (Omidvar and Kislov 2014; Wenger-Trayner 2013) highlight theory building as a combination of analytical (deductive) and creative (inductive and abductive) moves. Furthermore, his theory development process spanned both research and practitioner contexts, allowing for the development of a framework that could be directly applied to practice.

Case 1: Community of practice

The community of practice (CoP) framework (Lave and Wenger 1991; Wenger 1999) is commonly applied to educational technology research (Henderson 2015). The framework is also widely used in information management (Cox 2005), organization studies (Murillo 2011), health care (Kislov et al. 2011; Li et al. 2009), and more (Wenger-Trayner and Wenger-Trayner 2015).

In a published interview of Wenger-Trayner (Omidvar and Kislov 2014), Wenger-Trayner described the origins and phases of his theory development. In the 1980s, Wenger-Trayner worked in the computer science field studying artificial tutoring systems. However, he found cognitive approaches failed to provide insight into how people make meaning. He described, "We didn't have very good tools, in the community of computational approach to learning, to account for [making sense of the world]" (Omidvar and Kislov 2014, p. 268).

In the late 1980s, John Seely Brown invited Wenger-Trayner to join the Institute for Research and Learning where he began work with anthropologists, including Jean Lave. Wenger-Trayner described the transition as a "relief" (Omidvar and Kislov 2014, p. 268): anthropology provided new tools that he could use to understand meaning making. Although he doesn't provide details on the initial development of the community of practice framework, he described this period of time as "the first phase of our theorizing" (p. 268), where "the concept of community of practice became an important element, because it was a way to say to a community of scientists, 'Listen, we're not just telling stories. We have models; we can create models, too'" (p. 268). The original theory described a community of practice as a space that a learner gradually becomes part of. Thus, learning was described as a "trajectory into a community" (p. 268).

After the success of his work with Lave, Wenger-Trayner continued to develop his ideas through research and consultancy work. He described consultancy and research as "two contexts in which my conceptualization bumps against reality and I can see what resonates with people, what helps people make sense of the world" (Omidvar and Kislov 2014, p. 269). Research work supported knowledge development through methodology, while consulting allowed him to try new approaches and evaluate their effects. Wenger-Trayner described, "I'm so interested in theory that it doesn't matter if I'm consulting with a firm, helping a student with a piece of empirical research, or having a conversation with a friend about my work. In all these contexts, I'm refining the theory" (p. 269).

Through research and consultancy, Wenger-Trayner noticed complexities that the original CoP framework didn't address. For example, while conducting an ethnography of claims processors, he noticed that, rather than individuals becoming part of an existing CoP, employees created a new CoP in response to challenges. Through his consultancy work, he saw organizations struggling with knowledge management and considered what a CoP perspective might offer. Thus, Wenger-Trayner made a "figure/ground switch" (Omidvar and Kislov 2014, p. 268): instead of considering a CoP as a pre-existing structure that facilitates learning and identity development, he described learning as something that

could *create* a CoP. The second CoP framework, one that better fit his research results and that he felt was a more effective tool in practice, was published in 1999 (Wenger 1999).

Wenger-Trayner's CoP framework has continued to evolve. He has observed differences between competency in and knowledgeability of a domain. He has also considered interactions of multiple CoP's and the learning capability of systems. The third phase has expanded the framework to consider the relationships among multiple CoP's and how interactions affect knowledge and identity.

Designing CoP

Wenger-Trayner's descriptions of the development of CoP highlight how theory building can be viewed as a combination of analytical and creative moves, and how this perspective can lead to theory more useful to practice. Wenger-Trayner combined two types of knowledge building: a research-centered problem-focused approach and a practice-centered solution-focused approach. In both contexts, his understandings would "bump against reality" (the phenomenon). For example, empirical research (an ethnography) revealed a problem: the claims processors weren't only joining a CoP, they were creating a new CoP to meet new challenges. In his consultancy work, he was able to see the theoretical work from a different angle; he could see "what resonates with people, what helps people make sense of the world" (Omidvar and Kislov 2014, p. 269), supporting a solution-focused process. Conversations with others (in professional consulting, with students, and with friends) allowed for exploration of new ideas and modifications to the theory. He could try out the new ideas and evaluate how the ideas affected practice. The combination of analysis through empirical research and creativity through application brought theory into Wenger-Trayner's everyday work and supported the development of theory that fit his research findings, provided actionable perspectives, and formed a cohesive whole.

In this case study, we explored theory development from one design perspective: design as a combination of analysis (focus on a problem) and creativity (focus on a solution) (Lawson and Dorst 2009). We demonstrated how Wenger-Trayner's descriptions of the development of CoP reflect this perspective. However, design is not just combining analysis and creativity—it can also be viewed as reflection-in-action and meaning making through dialogic interpretation. In the next section, we use the development of the TPACK framework to illustrate a second perspective on designing theory: reflection-in-action.

Designing theory as reflection-in-action: TPACK

Donald Schön (1983, 1992) described design as interacting with a situation and reflecting on the results, or "reflection-in-action." Practitioners reflect-in-action when they adjust their actions based on what they see, often in a tacit manner. Schön described a "conversation with the situation" as a type of reflection-in-action. From this perspective, design is a process of acting, reflecting on the result (the "back-talk" from the situation), and responding accordingly. The back-talk includes findings of empirical research. Reflection-in-action supports a deeper understanding of the phenomenon in question. Schön described, "The unique and uncertain situation comes to be understood through the attempt to change it, and changed through the attempt to understand it" (1983, p. 132).

In the next case study, we use a reflection-in-action perspective to describe the development of TPACK. We do this by focusing on the physical representation of the framework. The figure provided a form that the theorists could reflect upon through theoretical

and empirical work, and over time the figure—and the framework it represented—became more refined to better meet the criteria of fit, actionability, and wholeness.

Case 2: TPACK

The TPACK (or technological pedagogical and content knowledge) framework describes the kinds of knowledge required by teachers for successful integration of technology in teaching. TPACK builds on Shulman's (1986) pedagogical content knowledge, updating it to include technology.

In early stages of their work, Mishra and Koehler applied four elements—technology, pedagogy, content, and their representations—to analyze research data from their work with practitioners in both K-12 and higher education contexts. The first visualizations of the framework were in the form of a square, with the four corners representing T, P, C and R; or as a tetrahedron with the four vertices representing the four constructs (Fig. 2). However, research results suggested separating representation from technology, pedagogy, or content. For example, Koehler et al. (2007) conducted a discourse analysis of faculty and graduate students working together to solve problems of practice faced by faculty members in their teaching. Through a close analysis of design-talk during development sessions (see Fig. 3), it became clear that representation as a construct was not supported by the data and that the three core constructs should be T, P, and C.

Although three core constructs were identified, the best way to represent their relationship remained unclear. As a first attempt, the square was replaced by a triangle, where each of the corners represented the three key constructs (T, P, and C), with the lines connecting the vertices representing overlaps between the knowledge structures (Fig. 4). For instance, the line joining P and C represented Pedagogical Content Knowledge or PCK.

Mishra and Koehler found the triangular representation more supportive of their developing understanding. Reflection on the representation suggested three additional synthetic constructs—TCK, TPK (which mirrored the previously identified PCK), as well as the overarching construct of TPCK. Technological Content Knowledge (TCK), for instance, was not an idea that had received much attention in the educational technology literature. TCK represented the idea of how content or subject matter was transformed due to technology, independent of teaching. It suggested that researchers and practitioners ought to focus on how subject matter or content itself had changed due to the advent of technology. The triangular representation also suggested an integrated way of thinking about the overarching construct TPCK.

That said, further reflection revealed that the triangle figure was both semantically inconsistent and aesthetically problematic. Specifically, the construct of knowledge, key to the understanding being developed, was represented by both a point (the vertex of the

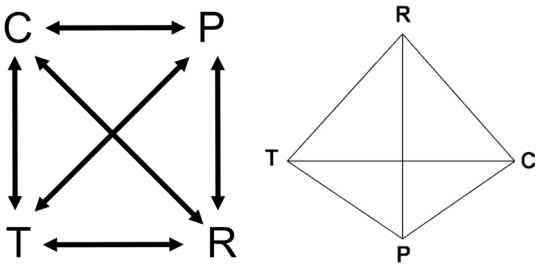

Fig. 2 Initial square and tetrahedral representations of the TPACK framework (with added vertex for *representation*)

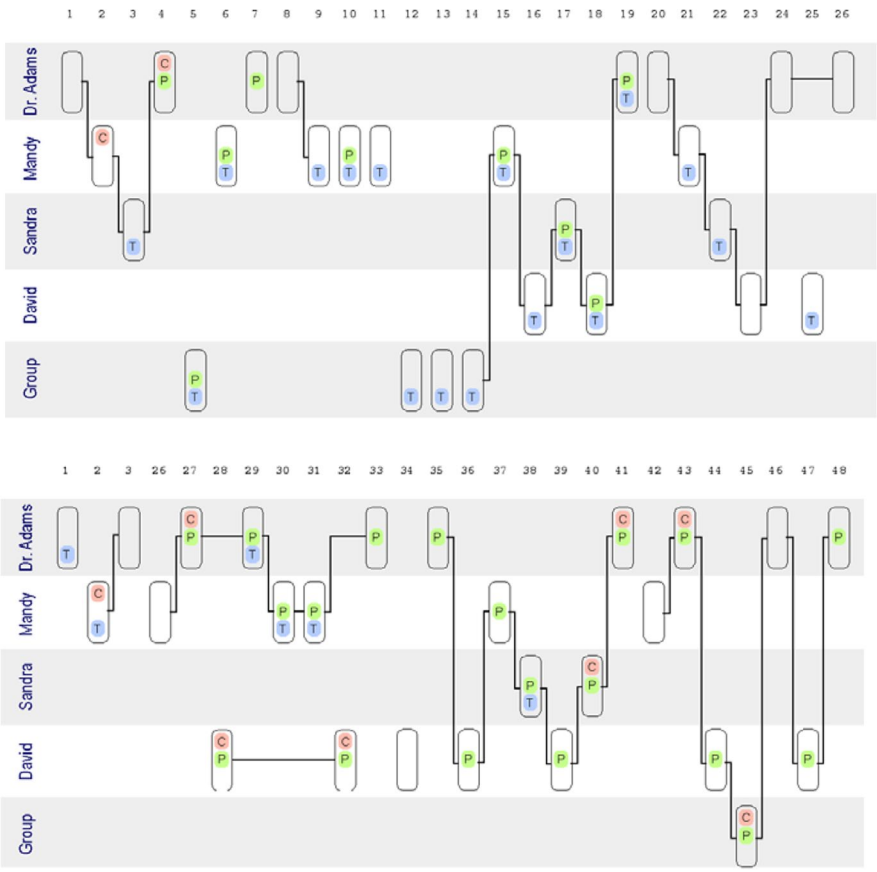

Fig. 3 Data analysis representation from Koehler et al. (2007), where *representation* was finally put to rest

triangle representing TK, PK, and CK) *and* a line (that joined the vertices, representing the PCK, TCK and TPK). Additionally, it wasn't clear where TPCK lived in the diagram. If TPCK was the whole triangle, it brought another visual device (that of an enclosed area)

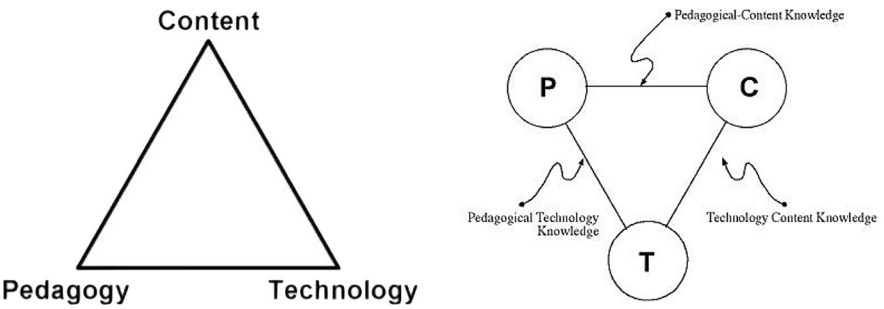

Fig. 4 The first TPCK diagram (2004) and the first appearance of circles. Note the inconsistency in representation between vertices or circles and the lines connecting them

into the picture. Increasing consistency in representation was essential for theoretical clarity. Moving from triangles to circles afforded this consistency: the knowledge domains were each represented as an enclosed space (see Fig. 5). Furthermore, the overlapping circles were more aesthetically pleasing and consistent with people's familiarity with Venn diagrams as a way of representing conceptual overlaps. The new representation offered a greater sense of wholeness.

The next step of the representation came during the writing of the chapters for the Handbook of TPCK for Educators, published by the American Association of Colleges of Teacher Education Committee on Innovation and Technology (2008). Through ongoing discussion, the editors and other authors of the handbook identified a significant gap in the TPCK framework—the framework ignored context, an element critical to any instantiation of technology integration. This gap was addressed by inserting a grey blob behind the three over-lapping circles, representing the relatively unstructured and unpredictable nature of contextual variables (Fig. 6). However, the asymmetry of the figure provided challenges for usability, and the (almost) final representation actually emerged from a need to place the diagram on a pin-up button! The canonical image (Fig. 7) ended up being one of the most cited images in educational technology, with significant impact on both research and practice.

Designing TPACK

The example of TPACK illustrates designing theory as reflection-in-action. In this case, we highlighted how visual representations were created and reflected upon. We discussed how many changes in the figure—and thus the underlying theory—were the result of discovering affordances and limitations of the existing figure. Attempts to use the theory and figure resulted in "back-talk" that highlighted both new constructs and inconsistencies, and the figure evolved accordingly.

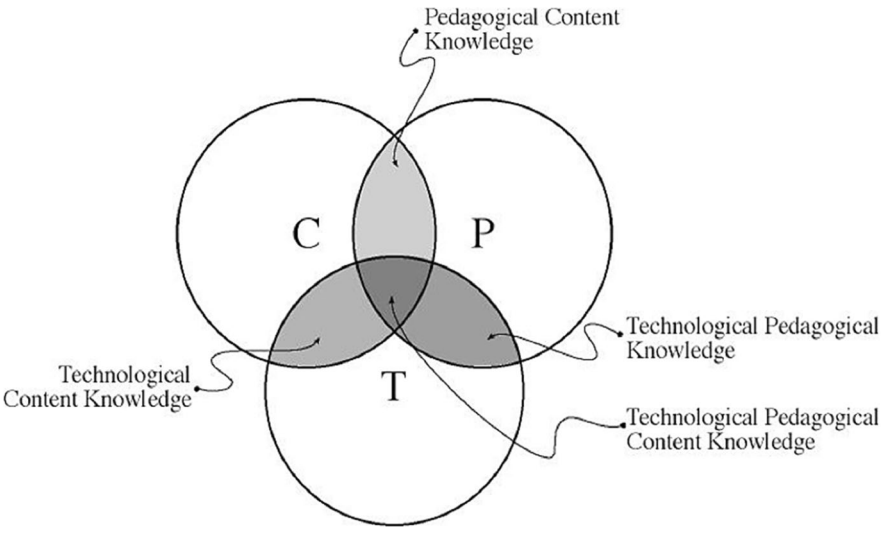

Fig. 5 TPCK framework as represented in Mishra and Koehler (2006)

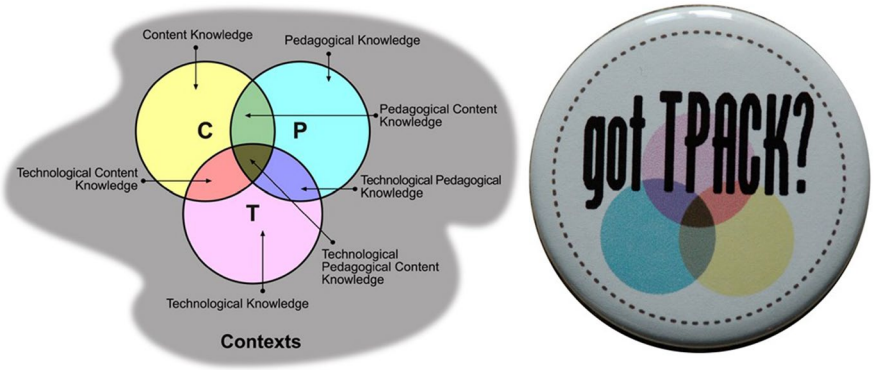

Fig. 6 Image used in the 2008 TPACK Handbook and on buttons designed for the 2009 TPACK special interest group at the Society for Informational Technology and Teacher Education International Conference

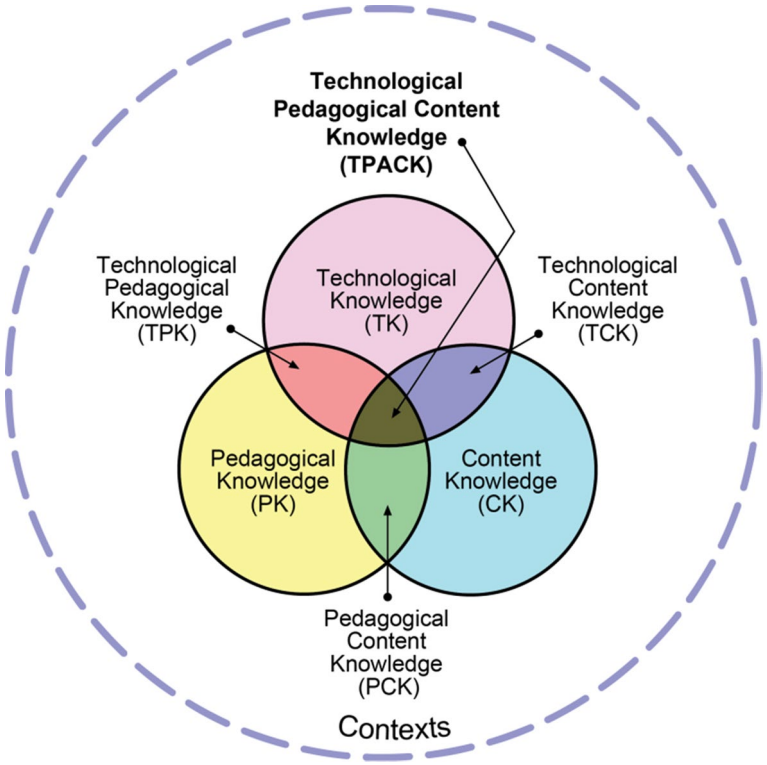

Fig. 7 The canonical TPACK image shared on TPACK.org

The reflection-in-action took several forms. First, a reflection on research data demonstrated that "representation" was not supported by data and should be removed. Second, the lines of a triangular representation suggested new synthetic constructs (TPK, TCK, and TPCK). Finally, further reflection on the triangular figure revealed visual contradictions

(representing knowledge as both vertices and lines), resulting in a new figure (overlapping circles) that was more consistent and communicable. Further tweaks in the design (most prominently in the inclusion of the dotted circle to represent context) came from discussions and feedback from the field and other experts. In the end, the back-talk from an attempt to place the figure on a button led to a more whole and balanced representation that both showed fit with the phenomena and was actionable—both for research *and* practice.

Through this process of creating a representation, reflecting on the results, and then revising, the figure—and the framework it represented—gradually became more preferred. Through ongoing creation and reflection, it increased in fit, actionability, and wholeness.

The description of the development of the representation of TPACK highlighted how theory building can be viewed from a different perspective of design: design as reflection-in-action. The TPACK example could also highlight design as a combination of analysis and creativity. For example, the analytical discourse analysis (Koehler et al. 2007) led to the removal of "representation" from the framework, while the move from triangles to circles came from a creative exploration of aesthetics. In the next example, we present a third perspective on building theory as design: creating meaning through dialogic interpretation.

Designing theory as creating meaning through dialogic interpretation: the five spaces for design in education

In the case of TPACK, adjustments to the visual representation of the figure both suggested and reflected a deeper understanding of the underlying theory. In other words, the theorists' actions led to new meaning about technology and education which led to a revised figure, and the revised figure itself then prompted new meaning. In our next example, we turn to hermeneutic philosophy to examine how designing theory could be viewed as creating meaning through dialogic interpretation.

Hermeneutic philosophy harkens back to practices of interpreting sacred texts. The interpreter comes to understand through interacting with the text. Interpretation moves between analysis of parts and whole, each informing the interpretation of the other. Importantly, interpreters bring their own beliefs and experiences (pre-understandings or what Gadamer (1976/2008) called "horizon of understanding") and project these onto the text. Understanding develops through dialogue between a text (which could be an action, object, image, or practice) and the person (including their pre-understandings). Interactions lead to revisions to understandings and an expanded horizon. Snodgrass and Coyne (1996) described a hermeneutic perspective on design:

> Design is an interpretative activity, one of understanding a design situation rather than of solving a problem. Designers come to the design situation with a pre-understanding of what the designed artefact will be. Even as they begin to examine the "text" of the design situation—the parameters that "define" it—they have a pre-understanding, a vague projection of the completed product. As they proceed with their interpretation and as their understanding increases by way of an interpretation of the parts, the projected whole is modified, refined, and clarified. This process is fluid, repetitive and continuous. It furnishes a kaleidoscope of ever-changing reflections, revisions, false starts and back- tracking, leading eventually to a clarification of the projection. (p. 23)

Coyne and Snodgrass's (1991) hermeneutical design has much in common with Schön's (1987) reflection-in-action. The designer changes a part and then reflects on how it affects

the whole. The whole might "talk back," suggesting new meanings of the parts. Interactions with the design "alters our understanding" and "refine and modify" leading to "richer and more comprehensive interpretations" (Snodgrass and Coyne 1992, p. 65). However, what hermeneutics adds to reflection-in-action is the emphasis on the positionality and expectations of the designer. From a hermeneutical perspective, interpretation is always affected by the pre-understandings of the interpreter, and the interpretive act changes the interpreter's perspective. Snodgrass and Coyne (1992) explained that from this view, design "involves a complex interaction between a myriad of social, economic, historical, physical, structural, and environmental factors" (p. 70).

Jahnke (2012) expanded on Snodgrass and Coyne's position through critical hermeneutics. Jahnke recommended an approach based on Ricoeur's writings, suggesting the interpreter (or designer) creates meaning by first distancing themselves from the text (or design) and then practicing "poetic redescription," such as exploring the space through metaphor. Jahnke explained that metaphors are "active in *establishing new meaning* that may be (partially) solidified in objects. Metaphorical deliberation might thus be seen as an ongoing process of open communication and poetic *creation of new meaning*" (pp. 38, 39, emphasis added). Poetic redescription may be one method of designing theory.

In the final case study, we bring the designer, the designer's positionality and expectations, and the surrounding context into designing theory. We present a case study of our own theoretical work in order to highlight the *experience* of designing theory. The case study begins with a description of our pre-understandings: the beliefs and expectations we bring to our work as well as our current context. We then provide a brief overview of the framework itself as well as a key milestone in its development. Finally, we dive deeper into a design session where we explored our framework through alternate representations and metaphor, and highlight how this approach supported the creation of new meaning through reinterpretation.

The framework we describe in this section is in its early forms of development and is constantly changing. In fact, during the review process of this manuscript major changes in the framework required rewriting this section of the paper twice! We have drawn heavily on design scholars such as Buchanan (1992, 1995, 2019) and Golsby-Smith (1996). However, as we have continued to develop the framework, we have made changes that make it more effective for our purposes and context. We share our experience here not to present a completed or novel framework, but to demonstrate the ongoing work of designing a framework for a specific purpose. With this example, we hope to bring our theoretical discussion into a concrete form closer to the practice of designing theory, much as we are calling for theorists in the LDT field to bring theory closer to practice.

Case 3: The five spaces for design in education

In our work, we view design as spanning a wide range of contexts. Historically, design began with a focus on artifacts—whether they be graphic in nature (such as a poster) or an actual object (such as a chair). Over time, however, the idea of design expanded to encompass the design of experiences (UX design), organizational systems, and even culture. In each case, the goal, as defined by Simon (1969), was to go from an existing state to a preferred one, but the scope of design expanded from its relatively humble beginnings. For instance, in the field of education, one could talk about a student designing a simple machine in a science class, a teacher designing a lesson plan, a principal designing a new bell-schedule, or the superintendent attempting to re-design the culture of the district.

Though all of these are examples of design, they cover a wide range of contexts, requiring different kinds of knowledge and expertise.

We bring this understanding of design to our work within a large education college at a public research university in the southwestern United States. The university is focused on innovation in education, as evidenced by the past five years of U.S. News and World Report "Most Innovative University" rankings (Faller 2019). The push for innovation is also seen within the education college, which is focused on addressing systemic problems in education.

The development of the five spaces for design in education took place through our work in university-school partnerships. In these partnerships, we support schools in addressing complex problems in education. Because of our broad perspective on design and because our context focuses on systems-level innovation in education, we projected a multi-level design perspective onto our partnership work. Early in our work, we found educators rarely exhibit such a broad perspective on design. As a result, we needed a way to communicate the scope of design to our partners as well as to better understand the different types of problems we were addressing across projects. For instance, in one school context, the principal wanted to address a stagnant curricular model in which neither students nor educators were particularly inspired or engaged. In another district, a public-school superintendent faced stiff competition for enrollment from heavily marketed and branded charter schools. She wanted to develop a district-wide identity that would resonate with the community. In yet another partnership, a superintendent sought to respond to the statewide teacher shortage by reorganizing teaching personnel into distributed teams. Across these partnerships, we began to see that the conversations about the scope and scale of what was to be designed varied. Some schools needed curricular responses while others needed structural responses, and we, as a design team, needed a way of understanding and talking about design that both captured its richness and clearly enunciated which aspects of design we were involved in.

We drew upon multiple sources in our attempt to develop an interpretation of design that could help us clarify our work and communicate with our partners. Our first attempt was based on a scheme developed by Stefanie Di Russo (2013) from Swinburne University, titled Stratification of Design Thinking (Fig. 8). We adapted the representation for education (Fig. 9). As we continued our work, Buchanan's (1992, 1995, 2019) writing about design for wicked problems became central to our thinking. To design for wicked problems, Buchanan suggested moving amongst four areas of design, or "places where one discovers the dimensions of design thinking by a reconsideration of problems and solutions" (p. 10). We also considered Golsby-Smith's (1996) four domains of design and how the skills required of the designer changes across the domains.

To create a visual representation of the spaces of our framework, we drew on Golsby-Smith's (1996) attempt to envision design orders as concentric spheres of complexity and ambiguity. We argued that the idea of design can be seen as playing a role in five key areas within the educational context. Each of these areas has its own discourse, or way of operating, which leads us to the central visualization of our framework (see Fig. 10). Table 2 summarizes our initial conceptualization of the spaces for design.

The first form of our framework was entitled "The Five Discourses of Design in Education." We wanted to emphasize the dialogic and communicative aspects of design, as we also saw these dimensions as central to what we were trying to do in our partnerships. We also drew on Gee's (1990) "capital-D" Discourses. Gee (2011) described Discourses as being "composed of distinctive ways of speaking/listening and often, too, writing/reading coupled with distinctive ways of acting, interacting, valuing, feeling, dressing, thinking,

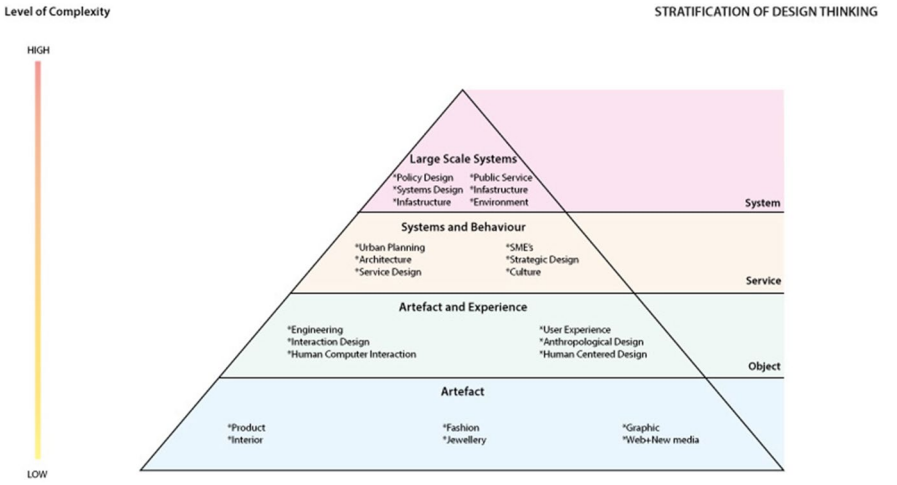

Fig. 8 The stratification of design thinking envisioned by Di Russo (2013)

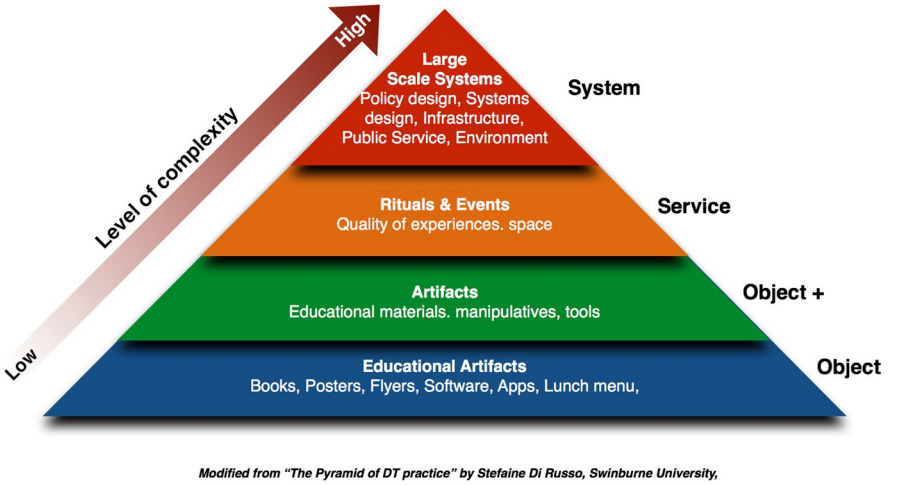

Fig. 9 A first attempt to capture the various levels of design thinking practice as they play out in education (inspired by scheme first introduced by Stefanie Di Russo)

believing with other people and with various objects, tools, and technologies" (p. 152). Gee's Discourse became an appealing way to conceptualize and distinguish between the various spheres and contexts of design activity: each was a way of seeing, being, and acting in a domain. We interviewed 11 professional designers across types of design and found each profession did seem to form its own discourse community with its own practices, tools, elements, knowledge, and criteria for judging quality (see Table 3). We were also influenced by Krippendorff's (2005) description of a design discourse. On the other hand, case studies conducted of various types of design proved less clear. Case studies highlighted the importance of fluidity across the design spaces, and how this fluidity might lead

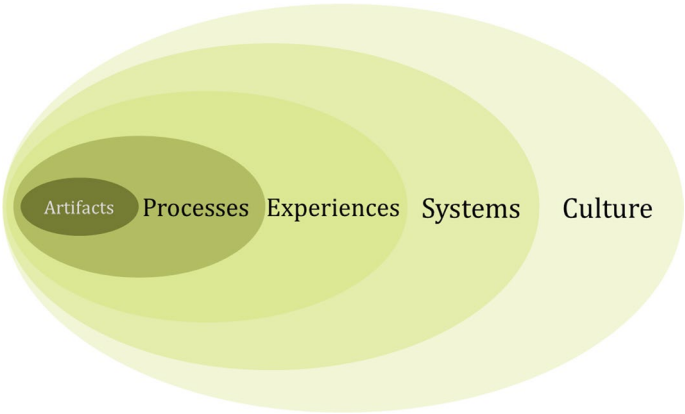

Fig. 10 Visual representation of the Five Spaces for Design in Education

to more effective designs. For example, an analysis of Disney "Imagineers" demonstrated that their ability to design across spaces led to high quality designs that integrated artifacts, processes, experiences, systems, and culture (Pérez Cortés and Close 2020).

As we evaluated the conflict we were seeing across empirical data, we considered the practical goals of our framework. We found that, while the term discourses was effective for describing disciplines of professional designers, it wasn't as effective for what we wanted our framework to do. We wanted to invite non-professional designers, particularly educators, to consider areas where they could take action to create change in education. We also wanted to emphasize the need to think across spaces of design rather than be confined to a separate design discourse. Thus, we changed our framework from "the five discourses of design in education" to "the five *spaces for* design in education."

Our theoretical work has also explored what is similar and different across the spaces and the relationships of the spaces. We have written more about these parts of the framework elsewhere (Mishra and Warr 2020; Warr et al. 2019; see also Talkingaboutdesign.com). Here, however, we take a deeper dive into how theorizing actually occurred in a single afternoon.

On a Friday afternoon, our team explored the five spaces for design (then called the five discourses of design) by creating alternate representations. Each team member drew several sketches of the framework, and these sketches anchored an interpretative conversation. For example, Kevin Close drew a juggler with balls representing artifacts, experiences, and culture. He linked processes and systems to the juggler (see Fig. 11). He connected the image to a poem and wrote the following:

> To shake our gravity up. Whee, in the air
> The balls roll around, wheel on his wheeling hands,
> Learning the ways of lightness, alter to spheres
> Grazing his finger ends,
> Cling to their courses there,
> Swinging a small heaven about his ears.
>
> —An excerpt from Richard Wilbur's *The Juggler*

Not all discourses of design interact with each other in the same way. Processes and systems manipulate other elements of design while artifacts, experiences, and culture

Table 2 Definitions and educational examples of the five spaces for design in education

Design space	Definition	Example
Artifacts	Stable objects that can be perceived through the senses	Curricular materials, tools, software, manipulatives, videos
Processes	A procedure or directions that can be used outside of the context within it was created to achieve a goal	Lesson plans, curricula, schedules
Experiences	A piece of time with associated sights, sounds, feelings, and thoughts	Activities, celebrations (graduation), learning communities
Systems	An organized and purposeful structure of interrelated and interdependent elements	Registration, certification system, degree program, evaluation systems
Culture	A pattern of shared basic assumptions that allows groups to perceive and interpret the world in similar ways, develop and communicate meaning, and transmit values to new group members	Perceptions of technology, schools, or education broadly

Table 3 Characteristics specific to design discourses

Aspect	Placement	Definition
Knowledge	Internal	What designers know
Judgement	Internal	How designers evaluate quality
Elements	External	What designs are made of
Tools	External	What designers use to design
Practices	Transactional	What designers do: The tricks of the trade

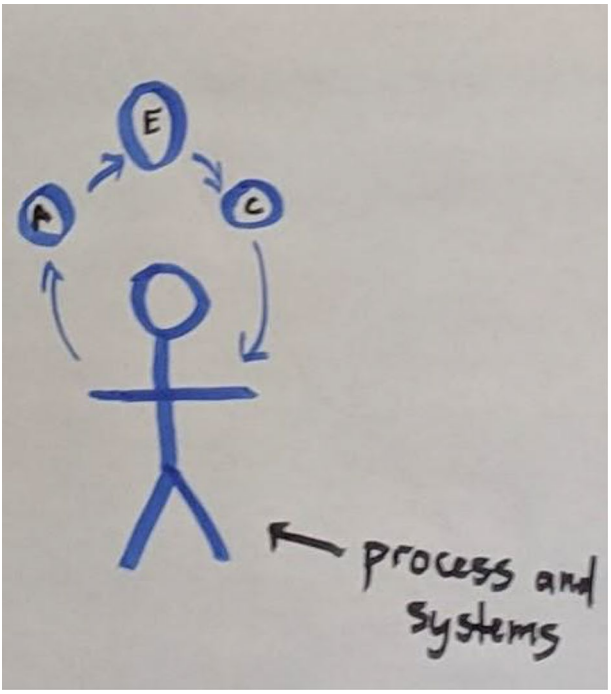

Fig. 11 Kevin Close's original juggler representation of the five spaces for design in education. See also https://talkingaboutdesign.com/the-juggler/

are more concrete elements. Processes and systems, however, are dynamic. They, like a juggler, tend to other discourses of design and their interactions. The juggler (the process and systems) work constantly and dynamically to keep the elements flowing as intended.

Melissa Warr also considered the differences among the spaces, and how processes and systems might have a different quality from the others. One of her representations was a house, with systems and processes forming the supporting walls, artifacts as the foundation, and experiences and culture as the roof (see Fig. 12).

Another visualization included nested circles which Amanda Riske described as a petri dish (see Fig. 13). Further reflection on this metaphor led to the idea of "culturing a culture" and the relationship between intentional and unintentional creation and interactions of artifacts, processes, experiences, systems, and culture.

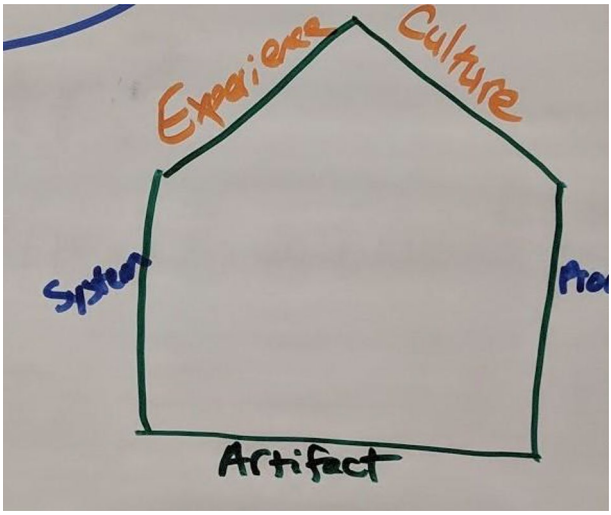

Fig. 12 House representation of the five spaces for design in education

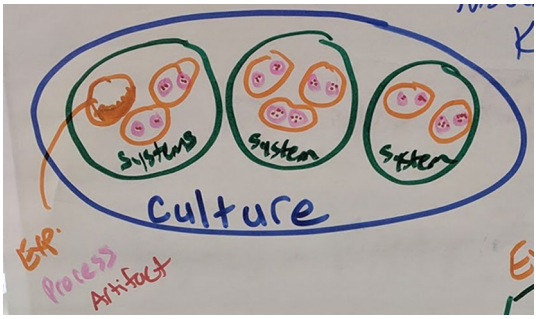

Fig. 13 Petri dish representation of the five spaces for design in education. See also https://talkingaboutdesign.com/the-paradox-of-the-petri-dish-aka-culturing-a-culture/

As a team, we walked around the room to view and discuss each sketch, drawing more sketches as we talked. Our conversation focused on the differences and interactions between the discourses, and whether these differences had significant implications for practice.

We continue to explore the implications of our new representations, and evaluate whether our re-interpretations improve fit, actionability, and wholeness. Whether or not we change our main representation of the five spaces, comparing the five spaces to a juggler, house, and petri dish supported a re-interpretation of the spaces, affecting how we view and apply them in our work.

Designing the five spaces for design in education

Our experiences with designing the five spaces for design in education highlights how designing theory can be viewed as creating meaning through dialogic interpretation. First, our theoretical work was impacted by our pre-understandings, including our context. What we bring to our theoretical work sets certain expectations, and these expectations shift as we interact in the space. We brought a systems-level design view to our partnerships because of our design background and because we were coming from an education college

focused on systems-level innovation. We found our partners often did not hold a broad perspective on design and we, ourselves, struggled to explain what we were doing in each partnership. Thus, we created meaning by re-interpreting partnership projects: we considered the challenges our partner schools were facing as multi-dimensional spaces for design, and we connected the types of spaces through the five spaces for design in education.

Our interpretative work didn't stop at the creation of the original framework. We continued to act and reflect in order to deepen our understanding and design theory with better fit, actionability, and wholeness. For example, we described a design session in which we created new meaning through alternate representations, a type of metaphor or "poetic redescription" (Jahnke 2012, p. 38). Jahnke (2012) explained:

> The point is that all the problem solving occurred within a process of seeking an evolving meaning… Imagination, metaphor, experiences, and other "irrational" thinking are necessary to coming up with new scientific concepts and innovations. What emerges is not an eradication of objectivity and problem solving, but a reversal of the relationship between problem solving and interpretation, particularly when wicked or ill-structured situations are concerned. (p. 39)

The sketches were a launching pad for the creative leap required for theory building.

Our metaphoric exploration also moved between parts and whole. For example, the juggler metaphor allowed exploration for how processes and systems might be conceptualized differently from the other spaces. This presents an interesting challenge for our framework as a whole: by presenting all the spaces equally, what are we revealing and concealing? New interpretations of these parts will change the whole. They will change how we work with our partner schools: what we focus on (Do we present processes and systems as the foundational design spaces? If processes and systems support the other spaces, should we always begin our work with them?), and the results. Our new whole affects the parts, continuing the hermeneutic circle.

In the end, some interpretations are more useful than others, but each has the potential to reveal some aspects of a phenomenon and conceal other parts. Drawing on Gadamer (1976/2008), Snodgrass and Coyne (1992) explained, "the validity of an interpretation is in the way that it stands up to the test of its practical application, its staying power, and the degree to which it gives rise to new insights and new disclosures of meaning" (p. 68). We created meaning through dialogic interpretation, changing our perspective and theory and, we hope, also changing practice.

Designing possible futures

The crux of the argument of this article is that applying design perspectives to theory building might help address the weaknesses of theory in LDT: that scholars have struggled to develop a theoretical foundation and that practitioners often find theory too far removed from their experience to be useful. Design addresses these challenges because of its flexibility, respect for complexity, future-focused orientation, and close connection to practice. Designing theory is fundamentally about creating new meaning through research and practice. This new-found meaning shapes our perspective, reveals action possibilities, and changes future practice. In this section, we discuss a central implication of design perspectives on theory: that through designing theory, we can design possible futures.

Redström (2017) described how design theory can be constructed through design practice. Although design theory is often conceptualized differently from scientific theory or the types of theory we generally work with in the social sciences (Beck and Stolterman 2015), his descriptions of how theory is made through design is relevant. In particular, his conceptualization of designing theory supports theory development in changing contexts—it supports working in a field focused on what could be rather than what is, a field that is constantly shifting. Perhaps of most interest here, he described how definitions can be made and re-made through design. He provided the example of the iPhone: the design of the iPhone redefined what a phone is. No longer is a phone a device in a home or office for audio communication. Through design, a phone changed from a device for audio communication to a personal resource for various forms of communication and connections as well as a tool that supports lifestyle and personal identity.

Design is always about moving from an existing to a preferred state. Theory development is about making—designing—a perspective on some phenomena, a perspective that is more preferred (exhibits better fit, actionability, and wholeness). This may include sketching physical representations of that perspective, outlining key terms and definitions, and describing relationships between constructs. When designing theory, scholars create meaning by highlighting certain aspects of a phenomena, the consequence of which is that people see things differently, opening new possibilities for action (see Dall'Alba 2009). In other words, designing theory goes beyond explaining what *is*. Designing theory means intentionally creating new perspectives that change what *will be*. Designing theory is about designing possible futures.

For example, the CoP theory redefined learning. It drew upon apprenticeship models, but the components of the apprenticeship model and the relations among them could have been defined and described differently. This is evident in how the theory itself changed across time. As the world and technologies changed—such as how the internet has led to more fluid integration of resources and highlighted the mobility of ideas and need for interdisciplinarity—Wenger-Trayner adjusted his model to something more effective for the new context. The revisions were only possible because he didn't see the theory as absolute, but rather something constantly shifting. He embedded theory development into his consultancy practice. As a result, the theory is designed to impact future practice, not just reflect current practice.

TPACK not only supported more effective technology integration, but redefined what teaching with technology *is*. It is not only using technology to support learning in general but also includes designing uses of technology that support content-specific learning. The re-definition changed perspectives and led to new methods of teacher education and practice. Evidence of this can be seen through current work on technology infusion, a position that emphasizes that technology integration is the responsibility of *all* teacher education faculty, not a single technology instructor in a stand-alone course. Infusion brings technology to the heart of teacher education—it brings technological knowledge directly into the pedagogical content knowledge context that already exists in teacher education, supporting the development of technological pedagogical content knowledge. Technology infusion is built on the TPACK definition of technology integration, and it is attempting to redefine teacher education as a whole.

Through the five spaces for design in education, we are attempting to redefine school change. We have observed many failed attempts at change and hypothesize that these struggles might be the result of a narrow perspective on *what* can or should be changed in a school context. Instead of focusing exclusively on the *things* of school—adding more computers or changing the curriculum—school change should involve design work across

the spaces of design: artifacts, processes, experiences, systems, and culture. By redefining school change in this way, we have improved the outcomes of our partnerships with schools.

Implications

Design perspectives support an active and practice-centered approach to theory building. Rather than viewing theory as something that appears at the conclusion of an empirical study, design perspectives recognize the ongoing nature of theoretical work and bring it closer to practice, resulting in more useful and impactful theory. The question, then, is how can the LDT field support design perspectives on theory building? What further work could buttress this perspective? These are important questions for continued exploration.

One of the challenges of a design perspective on theory building is that it may result in publication of theoretical work before theories are fully explicated, perhaps making it more difficult for others to build on the work. For example, Henderson (2015) described shifting definitions of the community of practice constructs as the theory was revised across time. Rather than critique the theory, he suggested those who use it need to be more specific about the definitions of the constructs they are applying, and he cautioned against instrumentalizing and oversimplifying the theory. Graham (2011) provided a similar argument concerning misuse of the TPACK framework. We believe scholars will be more effective if they approach this issue not by delaying publication of nascent theory, but by explicitly discussing uncertainty.

On the other hand, those who apply theory should be diligent in evaluating the limitations and appropriate use of a theory. Theory provides a lens into a phenomenon, and we assert theories are not necessarily *right* or *wrong*, but *better* or *worse* for a given purpose. As we have discussed, we believe criteria for effective theory depends on fit, actionability, and wholeness. We must consider whether a theory provides a useful focus for the issue at hand, and whether the theory has the type of empirical support required for the desired application. Selecting theoretical frameworks for application can, itself, be thought of as a design act: the scholar must try on a theory and consider what that theory reveals and conceals about a phenomenon. Choosing or developing a theoretical framework is ultimately about determining what will be most effective for a specific context, and that decision must be made in practice.

The argument put forth here is based on our position on theory building—a combination of what we have read about theory and our personal experiences. However, as we have mentioned, every perspective reveals some things and conceals others. What we hope to have revealed is how theory building can be an act of design, that it can be part of everyday research and practice, and that designing theory is designing possible futures. However, we recognize our perspective might conceal other important parts of theory development. For example, while not ignoring the need and role of empirical research in theory development, our perspective perhaps under-emphasizes the value and need for empirical research as part of theoretical work. We feel this is appropriate, as we believe what is needed in the LDT field is less structure and rigidness in theoretical work and a closer connection between theory and practical applications. We leave it up to others to identify additional pieces of theory development our perspective might hide. Ultimately, we invite scholars to try on this perspective and evaluate the results.

Conclusion

In this article, we have taken a journey through theory and design in order to argue that viewing theory building from design perspectives might help the LDT field address current weaknesses: a weak theoretical foundation, and theory disconnected from practice. After explaining multiple perspectives on theory, we explored designing theory from three design perspectives: design as a combination of analytic and creative moves, design as reflection-in-action, and a hermeneutical (dialogic interpretation) approach to design. Although each perspective comes from a different philosophical orientation, each gives insight into designing theory. We believe each meets Snodgrass and Coyne's (1992) criteria:

> A model of design is not to be assessed by its logical coherence, but by the degree to which it: approximates or fits the design process as known from first-hand experience; shows itself to be appropriate and useful in its application; is open-ended and, thus, offers the possibility of multiple interpretations; is rich in those interpretations and broad in the horizons it discloses; and is capable of generating other metaphors. (p. 73)

We hope our perspective on designing theory also meets these criteria: it matches the experience of theoretical work, is useful in application, allows for multiple interpretations, and broadens horizons.

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Melissa Warr (http://melissa-warr.com) is a doctoral candidate in the Mary Lou Fulton Teachers College at Arizona State University. Her research blends teacher education, design, creativity, and technology.

Punya Mishra (http://punyamishra.com) is Associate Dean of Scholarship & Innovation in the Mary Lou Fulton Teachers College and affiliate faculty in the Herberger Institute for Design and the Arts at Arizona State University. He is internationally recognized for his work in technology integration in teaching; the role of creativity and aesthetics in learning; and the application of design-based approaches to educational innovation.

Ben Scragg is the lead design strategist in the Office of Scholarship and Innovation in the Mary Lou Fulton Teachers College at Arizona State University.