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ARTICLE

Learning to see complexity: teachers designing amidst indeterminacy

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ABSTRACT

Scholars have called for considering professional learning (PL) through the lens of complexity. One lens for operating amidst complexity is design. Designers thrive in complexity because of the responsive nature of their work; a designer develops their practice in response to a particular situation, adapting as it changes. Thus, a design lens is useful for navigating complexity in teacher learning and practice. As a designer, a teacher learns and practices in a classroom amidst complex nested systems. Design calls for seeing beyond traditional, linear practice; experimenting with new approaches; and adjusting those approaches in response to the situation's feedback loops. In this article, we illustrate the relationship among complexity, design, and PL through examples from four teachers who participated in a design-centred PL program before and during the COVID-19 pandemic. The program aimed to support teachers in a creative design approach to address a problem of practice. Analysis highlighted that when teachers needed to learn and practice amidst complexity, it was difficult to see possibilities outside of traditional practice and to perceive feedback from the situation. Our analysis suggests that a focus on finding non-traditional approaches and listening to disruptive feedback might support teachers to learn and practice amidst complexity.

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Teachers work in complex contexts. Complexity exists along a range of dimensions: in the rich variability of talents, passions, and histories students bring to the learning context; in classrooms, including their design and architecture; and in schools and the broader administrative, policy, economic, social, cultural contexts they are embedded in. Complexity is also inherent in the educators themselves, their background, knowledge, and more. Traditional approaches to teaching and learning have attempted to sanitise this complexity, seeking to identify and create 'best practices' that can be implemented 'with fidelity' across contexts (Strom and Viesca 2021). Educational research that aligns with such approaches apply a form of linear logic: if a teacher does this, a student will learn that. These approaches, however, ignore, and even deny, the life experiences, cultures, and identities of diverse students and teachers; the contexts they work within; and the critical role these factors play in how they make meaning out of a situation (Warr and Wakfield 2022). In contrast, acknowledging and recognising the existing complexity, i.e. viewing teaching and learning through the lens of complexity, values the reality of educational contexts and the participants in it. This inherent complexity was brought home during the global pandemic, when existing structures and processes had to be dramatically re-envisioned. This experience

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emphasised that ignoring complexity in education was 'nothing short of an ethical imperative' (Strom and Viesca 2021, p. 209).

In this article, we apply complexity and design lens to interpret what happened in a particular professional learning program for a group of educators in a rural school in the southwestern United States during the pandemic. We use the term professional learning (PL) to refer to a form of in-service teacher education that is closely connected to practice, emphasising the need to support authentic professional learning (Webster-Wright 2009). In the PL program we describe, the educators, like most teachers around the world, had to quickly switch to remote instruction as a result of the pandemic. As a part of this PL program, teachers worked with the first author (a doctoral candidate from a partner university), sharing their struggles and successes, and their feelings about their role as a teacher during a pandemic. Although their context was complicated and volatile, their work was professional and personal. This collaboration provided an opportunity to investigate the interactions of complexity, design, and professional learning with the personal lives of teachers. It revealed the challenges that emerge from operating in a complexity while providing insight into the personal meaning-making aspect of teachers' design work.

In this article, we combine diverse theoretical concepts and data from a professional learning experience to demonstrate the value of taking a designerly view on teaching and reflection in complexity. We frame this discussion within Schön's (1983) concept of reflection-in-action and draw on the rich literature of the design professions. Reflection-in-action is a common construct used in professional learning literature, but our design-focused interpretation and application focuses not on a reflection of what *is* but on a reflection of what happens when we experiment with what *could be*. We illustrate these key ideas with examples from a study of a professional learning program. We use these examples not only to support the argument of teachers as designers but also to identify a somewhat surprising finding that highlights a barrier teachers might face when engaging in design work. Specifically, before a teacher-designer can experiment with what could be, they must first be able to see that there are many possibilities, none of which are right or wrong, but many of which hold possibilities for productively understanding and interacting with a situation. Our analysis indicates that this *indeterminacy*, borrowing a term from Buchanan (1992), was often difficult to acknowledge and recognise, becoming an initial barrier to productive practice in complexity. At some level, it was a personal struggle around beliefs, identity and experiences that needed to be resolved before there was any change in action.

Our argument focuses on five key ideas about design, complexity, and teaching. First, we argue that teaching and learning are complex phenomena, plagued by indeterminacy. Second, recognising this makes teaching particularly amenable to design-based approaches because design always operates within indeterminacy and complexity. Third, as a consequence, it is conceptually and analytically productive to see teachers as designers. This leads to our fourth point, that teachers can use designerly reflection-in-action and other design-based strategies to manage and positively function in complexity. Finally, taking a critical hermeneutical stance to design and reflection allows teachers to overcome key barriers and supports their meaning making and action in such situations.

In the next section, we provide the theoretical background for each of these ideas. Then we describe the PL program and briefly outline our data collection and analysis methods. Next, we build on these ideas by describing events that occurred during the program, highlighting barriers and opportunities we observed. Finally, we discuss the potential these ideas hold for supporting teachers' practice in complexity and offer implications for professional learning and practice.

Contextualizing complexity, design theory, and teachers

In this section, we provide the theoretical background for the five central ideas outlined above, starting with exploring the complexity of teaching and learning.

Teaching and learning are complex phenomena

Complexity theory provides a frame for considering and acting on complex phenomena in general, and professional learning and practice in particular (Cochran-Smith *et al.* 2014). In essence, complexity theory is a transdisciplinary approach that draws from a variety of fields to provide a nuanced perspective on learning systems, including the dynamics of teaching and professional learning (Strom and Viesca 2021). This approach offers a departure from linear and reductionist views and has significant implications for research methodology, analysis, and design in professional learning.

The key idea in understanding complex systems is that they are made up of many interrelated components which interact through complex feedback loops. Complex systems demonstrate several key characteristics (Byrne and Callaghan 2014, Cochran-Smith *et al.* 2014). They are nested in and interact with other systems and sub-systems. They are dynamic: constantly changing and adapting, growing and learning from feedback loops. They are non-linear; a small change can have a disproportionate effect or vice versa. This makes it difficult to understand and predict the behaviour of the system overall, even if we understand the functioning of each of the components, often described as 'the whole being greater than the sum of its parts' (Byrne and Callaghan 2014, p. 4). Since complex systems cannot be adequately understood by breaking into parts, any approach to operating in (or studying) complexity requires interpreting the system as a whole.

When applied to teaching and learning, complexity demands a recognition of the multitude of factors that interact in complicated and unpredictable ways in the teaching-learning context. It requires accepting that teaching is contextual, often limiting the generalisation of solutions from one context to another. Complexity highlights difference, be it in recognising the intersectional identities of teachers and students, or the impact of the broader social and political systems within which education functions (Authors 2022). This change in view has significant implications for what it means to be, act, and function as a teacher, and on the kinds of research that we can conduct.

In this article, we propose that one way to conceptualise, address, and act on this complexity in teaching is by applying a design lens to teaching learning and practice. We argue that design, as existing in the realm of the complex particular (see Nelson and Stolterman 2012), is ideally suited to provide us with the tools of dealing with the challenges of living and working within a complex system. Understanding teaching through design means considering phenomena and engaging in deeply contextualised action: with a particular teacher, in a particular classroom, in a particular school, in a particular educational system, and during a particular period of time (Author 2022).

Design operates in complexity

Design is a process of acting on the world, or as Herb Simon (1969) described, of 'devising courses of action aimed at changing existing situations into preferred ones' (p. 111). The phrase 'existing situations' includes an acknowledgement of the current context in all its complicatedness, not an ideal or abstract situation. Simon's definition also suggests there is humility inherent in what a designer does: designers are willing to push forward to a better state, aspiring not for perfection but for improvement.

As a mode of operating, design also serves complexity because it is active and emergent; it is responsive to – and even thrives in – contexts that 'don't stand still' (Pendleton-Jullian and Brown 2018, p. 159). Rather than merely designating specific actions beforehand, a designerly approach works with complex contexts as they emerge, striving for 'resonance between new things made, new actions taken, and the contexts in which these new things and actions reside' (Pendleton-Jullian and Brown 2018, p. 159). Because these components interact in intricate and unpredictable ways, complex systems demonstrate indeterminacy: there are no right or wrong solutions and the consequences of the designer's actions cannot be fully predicted ahead of time. Any action will have both predictable and unpredictable

consequences, interacting not just with the complexities of the system but also the uniqueness of the context. Designers are sensitive to this complexity and are forced to make moves without necessarily knowing how the situation will respond. They then consider the system's response, and use what they observe to adjust their understanding before taking further action. In other words, a designer 'learns his or her way towards a solution' (Dorst 2019, p. 66) amidst complexity.

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

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

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

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

Because indeterminacy means there are many possible interpretations of a situation and complex systems cannot be taken apart to be analysed, designers must make choices – choices driven by data but also by expertise and experience. These choices are often represented as design moves, preliminary 'sketches' that allow designers to see and understand how the situation responds. A sketch represents a 'frame' for the problem – an externally imposed structure that can then be evaluated. Since it is externally imposed, the frame is not necessarily emergent from the task at hand but rather is brought into play by the designer based on their experience, their prior engagement with similar (though not identical) design tasks. The frame may offer some opportunities and possibilities to explore but may also lead to dead ends. Either way, the frame helps the designer develop a deeper understanding of the contours of the task at hand. This new understanding can be used to repeat the process, moving the design forward.

What is important to understand is that the creation and imposition of a frame is a critical move in temporarily taming the complexity of the situation. Imposing a frame on a situation and interpreting the results is at the heart of what Donald Schön (1983) called reflection-in-action. Because the situation may respond differently every time, this type of reflection-in-action is how designers manage complexity. We will return to reflection-in-action soon, but first we discuss the relationship between teachers and design.

Teachers are designers

Like designers, teachers take existing situations (for example, their students' current knowledge or understanding) and devise ways of moving them to something more preferred (a change in knowledge or understanding). Teachers' designs might include tangible items, such as worksheets, bulletin boards, or uses of technological tools, as well as intangible things such as classroom procedures and lesson plans (processes), field trips (experiences), and even the culture of their classroom (see Warr and Mishra 2021). Teacher design work also encapsulates professional leadership, as teacher-designers collaborate to address intransigent problems in their specific contexts.

As designers, teachers function in situations of complexity and indeterminacy, where complete information is rarely ever at hand, and actions have to be taken given the immediate demands of the job at hand. A simple exercise that brings home the point that teachers are designers is to take sentences and passages that describe design and how designers function (such as the passages above) and replace the word *design* by '*teach*' and the word *designer* by '*teacher*.' The fit is uncanny. It is no surprise, given this overlap, that many have claimed that it is productive to see teachers as designers (e.g. Carlgren 1999, Goodyear 2015, McKenney *et al.* 2016).

[The authors] (2021) delved into this question of '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?' Their analysis provided a map of the landscape of key literature in the area and highlighted the many ways in which teachers can be seen as designers. In fact, they argue for going beyond seeing teaching as a practice that includes design activities but rather that it should 'be considered a design profession' (p. 10). Furthermore, they suggest that this would provide a 'holistic perspective on who teachers are and what they do . . . in complex and ever-changing contexts" (p. 12). If, however, the idea of teachers and designers is to have meaning beyond merely a change in labels, it is important to see what this new perspective provides us, analytically and functionally. First, seeing teachers as designers underscores the fact that teachers, as practitioners, do not simply observe or analyse complex systems: they act on and interact with them, both individually and collectively. It is through this interaction that they come to build an understanding and interpretation of the situation. Moreover, one way to understand this interaction is through Donald Schön's concept of reflection-in-action and its relationship to teaching. At some level this is not a new connection being drawn, it is a construct that has often been used in the education literature, but we take a design perspective by building on Schön's claim that reflection-in-action is a 'generic design process' (p. 77) that underlies all design work, regardless of the type of design being engaged in.

The literature on reflection in teacher learning (often termed *reflective teaching*) is deeply influenced by Schön's ideas and has positively impacted the field. The introduction of reflective teaching was in response to the increased emphasis on mechanical and technical perspectives on teacher's work (Zeichner and Liu 2010), a challenge that we also seek to address. However, the term *reflective teaching* itself has become muddied and is often used uncritically (Rodgers 2002, van Manen 1995, Zeichner and Liston 2014, Zeichner and Liu 2010), and 'In becoming everything to everybody, it has lost its ability to be seen' (Rodgers 2002, p. 843). Additionally, often a somewhat impoverished conceptualisation of Schön's ideas have been transferred to the teacher learning literature (Zeichner and Liu 2010), and there is a richness to the idea that is important for our field to engage with. It is on that idea that we focus the next section.

Teachers can use designerly reflection to manage complexity

Early uses of reflective teaching are similar to the concepts we present here. For example, Zeichner and Liston (1996) emphasised the role of reframing problems as well as the consideration of institutional and cultural contexts in reflective teaching. They described that 'the way in which [teachers] solve [educational] problems is affected by how they pose or "frame" the problem. Reflective teachers think both about how they frame and then how to solve the problem at hand'

(p. 4–5). However, the literature on reflective teaching differs from the design literature in the *focus* of the reflection. Zeichner and Liston (2014) described the 'stuff of reflection' as teachers' emotions, metaphors, and images as well as broader cultural discourses of teaching, schooling, and education. In design, however, the object of the reflection is the materials of the situation as they react to the designer's actions. The designer purposefully creates in and interacts *with the situation* rather than reflecting on what is already there. Then, the materials of the situation – as dynamic parts of a complex system and the focus of reflection – respond in unexpected ways, opening possibilities for other moves, leading to a 'conversation with the situation' (Schön 1992, p. 125). To differentiate these perspectives on reflection, we label the design perspective on reflection as *designerly reflection.*

In contrast to reflective teaching, in designerly reflection having a conversation with the situation means both the designer and the situation are interacting to produce something new. This is similar to how people create a shared understanding through talking with one another. In constructive conversations, individuals do not speak knowing what the other will say or only to understand themselves. Rather, they say something to find out what the other will say, which then impacts their next turn. The result is a conversation constructed between two or more individuals, each playing a significant role in shaping the conversation. Schön and Wiggins (1992) describe this process of having a 'having a conversation with the materials of a situation' (p. 135) as follows:

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

Designerly reflection is a type of inquiry or probe. It is not a purely cognitive intellectual activity of looking back on one's actions but rather an active process of engaging with the complexity of the situation through framing, probing, studying the impact of actions, and making changes based on what one sees. The inquiry is found through seeing a different way of interpreting and interacting with the complex situation. The inquiry is actively placed on the situation, and the conversation moves forward in a fluid and even 'ephemeral' (Schön and Wiggins 1992, p. 125) manner. Schön (Schön 1983) described:

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

In other words, designerly reflection is integrated with implementation because it is a reflection on the situation; it is imposing a certain interpretation on the situation, seeing what happens, and responding again.

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

> A practitioner's reflection-in-action may not be very rapid. It is bounded by 'action-present,' the zone of time in which action can still make a difference to the situation. The action present may stretch over minutes, hours, days, or even weeks or months. (1983, p. 62)

Designerly reflection is something that occurs when 'action can still make a difference to the situation.' While it may occur rapidly when the situation is a single lesson and teachers respond to student reactions, if the situation is a unit, a semester, or something of unknown length (such as the COVID-19 pandemic), changes can be made across a longer time frame in a less rapid way.

Understanding the shifting situation as the object of reflection is critical to understanding design because design is a combination of learning about and *changing* something. These two activities,

learning and changing, work in tandem: 'The unique and uncertain situation comes to be understood through the attempt to change it, and changed through the attempt to understand it' (Schön 1983, p. 32). In order to reflect-in-action, the situation must be able to be changed, and new interpretations come through making these changes and perceiving the results.

The central thesis of designerly reflection – and what connects designerly reflection to complexity – is that designers reflect on the situation as it reacts to their actions, and this reaction is responsive to the inherent complexity of the situation. In other words, designers do not need to understand the elements of a complex situation, they only need to build on its response. This allows them to productively create in complexity.

Critical hermeneutics, identity, and meaning making

Although widely used, there have been some criticisms of Schön's framework from both the fields of professional learning and design (e.g. Jahnke 2011, van Manen 1995, Zeichner and Liu, 2010). For example, Jahnke (2011, 2012) highlighted several limitations of the framework, including the somewhat passive 'inert self' of the designer; the artificial separation between subject and object; and a lack of recognition of the dynamic relationship between the subject, object, and the broader world. To address these limitations, Jahnke argued for a *critical hermeneutic* perspective on design where both the situation *and* the designer is changed through the design process. Design could be thought of as an act of interpretation, where 'all problem solving occur[s] *within* [emphasis added] a process of seeking an evolving meaning' (Jahnke 2012, p. 39). Design becomes an act of sensemaking where the designer creates new ways to interpret (make meaning of) a situation and considers the results of those interpretations. This meaning making emerges through creative action, supporting an integration of the self and a constantly evolving – and complex – global context.

A critical hermeneutic perspective highlights the complexity-embedded personal meaning making nature of design. Design supports personal meaning making in complexity and indeterminacy; because there are many ways to frame a situation, and no single correct way, designers must create a frame that unavoidably reflects their own beliefs, identity, and experiences. The result is a unique interaction of the designer (or teacher) and the situation. Furthermore, personal beliefs and experience not only influence designers' framing and actions, they also influence how designers interpret backtalk from the situation. This further solidifies their unique perspective and ways of making meaning in these complex, indeterminate settings.

Although a critical hermeneutic perspective supports design as personal meaning making in complex and volatile contexts, this perspective is rarely discussed in the literature on teachers and design or professional leadership. However, there is a strand of professional learning research which has emphasised the need not just to situate teaching in the social context but also to consider the personal beliefs and identities of teachers as they play out in complex, yet, particular contexts (e.g. Beijaard and Meijer 2017, Clarke and Hollingsworth 2002, Korthagen 2017).

For example, Korthagen (2017) described:

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

Bringing this emphasis on teacher identity and beliefs to design's strength of operating in complexity offers new possibilities for teaching learning and practice.

In summary, we have discussed five key ideas: teaching and learning are inherently complex, design is a productive lens for operating in complexity, teachers are designers in a fundamental sense, designerly reflection supports practice in complexity, and, finally, identity and meaning making are of critical importance in teachers' design work.

Our conceptualisation of these theoretically-grounded ideas is corroborated through our research, in particular in our work supporting teachers in design work. In the next section, we provide a brief background of an example of our work, including research methods (a more complete description can be found in Authors 2021). Then we build on the key ideas described above through examples from a PL program conducted during the COVID-19 pandemic.

Complexity, design, and meaning-making in practice

To explore how teachers design in complex uncertainty, we applied an explanatory case study approach (Yin 2017) to a design-focused PL program conducted from February to August 2020 in a rural middle school in the southwestern United States. The PL program serves as a revelatory case (Yin 2017). Specifically, the unexpected interruption of COVID-19 highlighted the role of emergence and complexity in teachers' design work. The case is not a sample of a phenomenon nor is it meant to provide a generalisable intervention. Rather, it offers 'the opportunity to shed empirical light on some theoretical concepts or principles' (Yin 2017, p. 38) and supports analytic generalisations, or high-level theoretical concepts that can be further investigated in other contexts (Yin 2017).

The PL program was founded on the concept of teachers as designers (Authors, 2021) and was structured to encourage teachers to identify problems of practice, interact with these problems through creative techniques, and iterate on possible solutions. For example, in the initial workshops, teachers drew 'postcards' that described their feelings about their school and classroom in words and pictures. After discussing what they noticed about their work, the teachers decided to focus on school-wide student behaviour. In the next workshop, I[1] led the teachers through ideation exercises to consider possible approaches, with the teachers ultimately electing to use letter writing to learn more about their students' experiences.

The program was originally designed to meet two hours weekly for eight weeks. However, when COVID-19 led to closing the school, the format had to change. Beginning in March 2020, I met with the teachers online for an hour one to two times each week. We continued meeting through the end of the August 2020, ultimately meeting 23 hours over twenty sessions. In these sessions, the teachers and I continued experimenting with different types of moves for interacting with the problem space. For example, we read related research literature, continued to collect student perspectives, created artistic interpretations, and prototyped solutions. Although we were initially focused on teachers' challenges with student behaviour, our focus gradually shifted to approaches for building relatedness and connectivity in the school community.

Data collected included pre- and post-interviews, video recordings of all sessions, work samples, and researcher reflections. I conducted a pattern analysis of the data (Yin 2017), originally anchored by a proposition identified through a review of the scholarly literature on teachers and design: design-based professional learning can support both the development of professional practice and context-embedded professional knowledge. I used embedded units (the individual teachers who were part of the case) to explore and revise patterns based on the proposition.

A more complete account of this study and findings are presented elsewhere (Authors 2021). In this article, we build on the key ideas outlined above and focus on a notable phenomenon that we observed through our interactions with the teachers, a significant barrier that teachers faced as they worked to navigate the new complexities and indeterminacies that emerged due to the pressures of a global pandemic. Specifically, viewing a situation and its backtalk as indeterminate was a significant stumbling block that needed to be addressed before creative action could be taken. Moreover, it was working through this challenge, in deeply personal ways, that empowered teachers to address and to positively make meaning out of the situation.

Teachers designing in complexity: see-move-see

In this section, we begin by describing the design-based PL program, illustrating one interpretation of what it means for teachers to engage in design work. Then we use examples of the data to explain a surprising challenge: it was particularly difficult for the teachers to perceive indeterminacy in the context, which in turn prevented them from 'seeing' and 'acting' on the situation, or in other words truly engaging in a 'conversation with the situation.' In the next section, we provide a deeper description of how we conceptualised and supported teachers as designers in this program. Then we describe the challenge of seeing indeterminacy in the initial situation, identifying possible moves, and openly interpreting the situation's reactions to those moves. Finally, we consider how a critical hermeneutic perspective of design can enrich our understanding of the case.

Supporting teachers as designers

The PL program described here was created to explore how to support teachers engage in design and develop a designerly perspective on their practice. The initial goal was to help teachers design creative solutions to a self-identified problem of practice. The teachers originally focused on student behaviour, what they labelled as a lack of 'respect for adults.' As a participant-researcher, I guided the teachers in creative design activities that I believed would support them in interacting with this challenge. For example, the teachers brainstormed possible approaches to addressing their problem, asked students to write letters that expressed their feelings about their relationships with adults, and created new problem frames through metaphor.

A core piece of our theory about how to help teachers design was centred on encouraging them to implement new ideas in their school and classroom (make a move), consider the results (reflect on the backtalk), and revise accordingly. We began investigating the challenge teachers chose to explore – respect for adults – through both reviewing research literature and exploring students' perspectives. Just as the teachers were preparing to make a move by testing new ideas in their classrooms, the school closed down in response to the COVID-19 pandemic. This shifted our focus to the more immediate needs of the school and teachers.

We continued to meet online, discussing the challenges the school was having connecting with students and motivating them to complete packets of work that teachers sent to them. While reading research literature, one teacher came across the idea of 'relatedness,' and we refocused our efforts on how we might support relatedness in the upcoming school year. In particular, the school was acquiring devices for the students so school could be held online, and the teachers puzzled over how they might support relatedness in online learning. However, although we continued to explore these ideas, we were limited in our ability to implement them with students, what I believed was a critical step in the design process.

Originally, this inability to take action (make a move) appeared to stifle our design work. Designerly action calls for trying out possible moves, reflecting on how the situation responds to those moves, then refining and acting again. Because we had limited access to students, we were unable to receive direct feedback from how a design would operate in an educational context. However, we continued our work by designing activities for ourselves, reflecting on our own experiences with these activities, and making revisions for future use in the classroom. Through this process of designing activities, reflecting on the results, and using these reflections in revisions, I identified a challenge teachers had when engaging in design work: seeing indeterminacy.

Seeing indeterminacy

Through our collaborations, I observed that a major barrier to the teachers' design work was the ability to identify multiple frames that could be put on a situation. I connected this challenge with what Buchanan (1992) called *indeterminacy*. As previously discussed, indeterminacy describes complex situations where there are not right or wrong answers, but rather many possibilities or frames for moving forward. In complex situations, designers

will never have complete information about a situation and must create a frame—'even if it is arbitrary' (Schön 1983, p. 85) – act on that frame, and use the results to both learn about and act again.

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

The importance of seeing indeterminacy became salient as I attempted to help teachers design activities to address specific goals. During July 2020, I asked the teachers to design a brief online activity we could complete amongst ourselves. I created an example which we all participated in, then modelled a reflective conversation focused on understanding how we each experienced the activity. We then discussed what surprises resulted from the activity as well as what changes I might make to the activity to better meet my goals. I made the changes, and in our next meeting we again participated in and reflected on the revised activity.

It was only when I asked the teachers to design activities themselves that I began to understand the difficulties of seeing indeterminacy. Two of the teachers created writing assignments consisting of a list of prompts for students to respond to. The prompts were well thought out and interesting to engage with. After some reflection on our experiences completing the prompts, I asked the teachers what they might change to adapt the activities to better meet their specific goals. At first, they struggled to describe any changes. Eventually, they focused on changing the content of the prompts themselves but did not consider other possibilities (for example, changing activity structures such as whether students completed the work independently, in pairs, etc.). The writing assignments were built on an interpretation of learning as personal development built through independent reflection. Other interpretations – such as seeing learning as forming connections across people and ideas – would have suggested other design choices, but the teachers were not yet able to see these choices. This is a form of 'functional fixedness' (Duncker 1945) where the frames selected were narrow and limited in number, restricting the teachers from seeing possibilities and alternatives.

Later, when reviewing the data, I realised that my question of *what* the teachers could change to make the activities better meet their goals assumed that they knew which pieces of the activities they *could* change. They needed to be able to see the indeterminacy in their designs, to recognise that they were interpreting the situation in just one of many possible ways, leading to limited design choices. Other interpretations – and the corresponding design choices – could have also been made, offering new possibilities (in fact, as I will later describe, at the end of our work they did come to interpret the situation differently). On the outside, teachers were participating in a design task – they were designing an activity. However, internally, they were not quite viewing their work as a designer would; they were not seeing the situation as indeterminate. They were fixated on the 'subject matter' (specific writing prompts) rather than recognising, as Buchanan (1992, p. 17) would say, that the 'subject matter of design is potentially universal in scope.'

Helping teachers see the indeterminacy in a design might be an effective first step in moving them towards being a designer and thriving in complexity. However, simply seeing the indeterminacy is not enough. Designers must have some way to move forward in complexity; they must 'see, move, and see again' (Schön and Wiggins, 1992). To do so, they create one of many possible approaches (see), apply it to the situation (move), and then evaluate the consequences (see again). It is to this process of making a move (placing a frame on the problem) then perceiving the consequences that we turn to next. This is a cognitively challenging task because it requires acknowledging indeterminacy and complexity, and, at the same time, being willing to choose one among many possible frames as a way of temporarily reducing this indeterminacy and acting on the situation. Recognizing indeterminacy is essential to respecting the ground reality of complexity, but it can also be debilitating, preventing action. Creating a frame requires temporarily ignoring this complexity in order to act.

Moving and seeing differently

The design process opens up possibilities for surprise that can trigger new ways of seeing things, and it demands visible commitments to choices (frames) that can be interrogated to reveal underlying values, assumptions, and models of phenomena (Schön 1992, p. 131). In designerly reflection, once designers see something that might be changed or reframed in the situation, they must make a move, consider the consequences, and then use what they learn to continue with the design process. This move may be made through a mental act of seeing the situation from a different perspective or a more direct approach of directly acting on the situation, such as a teacher asking a question to find out how students are understanding a concept. The practitioner makes a move that helps them learn more about how the situation they are working with will respond. The response can then inform future moves, allowing the agency of the object being designed to reveal itself.

Furthermore, designers perceive the result of their moves in an indeterminate manner. Once a move is taken, the designer must then hear how the situation talks back. However, although the actants of a situation respond independently of the designer (Clarà 2013), the designer can perceive and interpret the backtalk in different ways; the backtalk becomes indeterminate *through* the designer. In other words, the way the designer interprets the backtalk makes it indeterminate, producing more possibilities for their next turn in the conversation. This means designers see indeterminacy in two ways: they see indeterminate options for moves they might make and then consider various interpretations and surprises in how the situation *responds* to the moves they make.

The significance – and challenge – of perceiving the backtalk in an indeterminate way became apparent as teachers conducted conversations around their designed activities. After we had each created a short activity and completed each other's activities, I asked teachers to lead reflective conversations about their activities. I hoped the conversations would help us interpret and build on the results of the activities (the backtalk from the situation). However, I found the teachers were not used to working in this way.

For example, when I asked one teacher (whom we'll call Virginia) to lead a discussion about her activity, she was not sure what questions to ask. I was puzzled at why this was difficult; she had been a significant participant in two similar discussions I had modelled, coming up with unique and interesting ideas to share with the group. Eventually, I suggested she ask us about our experiences with the activity. In the ensuing discussion, one teacher described discomfort when they saw a question that felt irrelevant to them. The result was a negative experience for this teacher. I felt we had found an unexpected outcome of the activity that Virginia could consider through a redesign of the activity. However, when at the conclusion of our discussion I asked Virginia what she learned, Virginia had difficultly using our discussion to identify changes to make to her design.

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

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

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

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

Virginia: Hmm. So, when we went through activities and being able to analyse not only why we did the activity, but what that activity produced. Specifically, when we are talking about, I think Ana was talking about the gratitude journals and having the students be aware of what they're grateful for, doing her journal helped analyse those things within myself . . . it's always good to be able to say, oh, I never thought about it that way before, or I never thought about *that* before.

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

'Seeing things differently' is at the heart of seeing indeterminacy – that there are different ways to perceive, experience, interpret, and act upon something. It is how designers create unique designs that operate in complex contexts. But it also highlights a different aspect of being a designer. The indeterminacy of the situation, including the indeterminate ways designers perceive the backtalk, means individuals can experience a situation in many different ways, ways that are unique to them. Design becomes not only about changing the situation, but also changing the designers themselves. This suggests that we ought to go beyond reflection-in-action to better account for the personal meaning making aspects of design. One such approach is Jahnke's (2011, 2012) critical hermeneutics.

Design as critical hermeneutics

Let's return to Ana's gratitude activity mentioned by Virginia in the previous section. Ana's decision to create an activity around gratitude came from a larger issue she was concerned about: she had witnessed students struggling to save money. Although Ana originally considered addressing this situation through lessons on financial literacy, Virginia suggested the challenge might be deeper than that; it might have to do with a potential 'poverty mindset' (see Payne 2005) of many of their students.

Ana researched the poverty mindset and found many options for addressing the situation. Eventually she imposed a frame by choosing to focus on gratitude. She reported, 'I can focus on gratitude at this time.' Over the following days, she wrote journal prompts that would support a mindset of gratitude. The teachers and I each completed the prompts. This is what Virginia was referring to in her interview when she connected 'seeing things differently' with 'analys[ing] not only why we did the activity, but what the activity produced.' In this case, seeing 'what an activity produced' went beyond the cognitive outcomes of the activity; Virginia connected personally to what was produced from Ana's gratitude activity. In an earlier workshop, Virginia provided more detail on this experience:

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

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

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

It's important to connect this example with Virginia's comment about seeing things differently and understanding what an activity produced. This personally meaningful experience helped Virginia see the indeterminacy of the outcomes of the activity; it created a unique and personal experience in her own life that couldn't be predicted through the initial activity design. Virginia's meaning making was a complex integration of her personal experiences, culture, and knowledge that, like complexity, was greater than a combination of parts.

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

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

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

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

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

For example, our (re)interpretation of the original situation (lack of respect for adults) as a need for gratitude, connection, and interaction was a possible interpretation from the beginning of our work together. However, we did not create this frame until the changes in the broader context suggested them. The result was a conversation amongst the designer (including personal beliefs, identity, and experiences), the situation, and the context. By acting as designers, the teachers increased their ability to integrate each piece through personal acts of interpretation, resulting in not only designed products and increased professional knowledge, but individual sensemaking. Design was a personal act of interpretation, a form of critical hermeneutics.

Discussion and implications

In this article, we used examples from a PL program to illustrate what it means for teachers to design and a potential obstacle in this design work: the difficulty of perceiving the indeterminacy of both the situation and the feedback from the situation. We discussed how, with support, teachers were able to begin taking on new perspectives in their design work resulting in rich interpretations and interactions between themselves, their beliefs and experiences, and the rapidly shifting and complex context. This supported a view of design as an act of critical hermeneutics, where 'all problem solving occur[s] within a process of seeking an evolving meaning' (Jahnke 2012, p. 39). In other words, in the process of changing the situation, the teachers themselves experienced change.

In this case, the broader context of the study – what might be considered outside the scope of the situation that could be directly acted on – changed in significant and unexpected ways. The teachers were dealing with not only the complexity inherent in their everyday practice, but also disruptions from a global pandemic. In this context, teachers could not rely on 'best practices.' Instead, their learning and practice needed to fluidly respond to social and political events, finding novel approaches to support the students in their school. They were pushed to practise in a manner that respected and responded to the complexity of teaching during a global pandemic.

Although this situation was challenging – even paralysing at its onset – a designerly way of working supported the teachers in productively navigating this complexity. In fact, the design work helped them find personal and professional meaning out of this complexity. In the interviews conducted at the end of the program, the teachers all expressed that participating in the program impacted their view of themselves as professionals and changed their practice. They described experiencing personal change, focusing more on the needs and experiences of students, finding more creativity in their practice, and having more confidence in trying new things (Authors, 2021).

Although these results are not generalisable in the traditional sense, they do provide theoretical insight (see Yin, 2017) into the concepts of design, complexity, designerly reflection, and critical hermeneutics – and how they interact with the idea of teachers as designers. Specifically, design work has the potential to support teachers in experiencing meaningful practice in complexity, where the complete situation cannot be predicted or even understood. However, to be successful in this type of work, teachers might need support in coming to perceive the indeterminacy of the situation and feedback. Teacher educators – in both pre-service and in-service programs – can support professional learning by providing opportunities for creating multiple frames for various situations, including pedagogical approaches, behavioural challenges, school culture, and educational systems. Importantly, as is central to design, they should have the opportunity to try out the frames and interpret the results from various perspectives. Practicing seeing indeterminacy has the potential to develop creativity in the practice of teaching as well as increase teacher confidence in navigating complexity.

Additionally, this type of design work places teachers as leaders of their own learning and practice. Because design embraces complexity and is deeply contextual, teachers, with their intimate understanding of their students and school community, naturally move into leadership roles as they engage in dialogue and enquiry in relationship to their work. Through seeing new and personally meaningful frames – perspectives that were previously hidden because of the indeterminacy of the situation and backtalk – teachers uncover possibilities for action and are empowered to direct their own learning and practice towards these actions, even amidst complexity.

Although the impact of this work on students is unknown, it is reasonable to conclude that teachers who develop a creative and flexible practice are more successful at supporting the intersectional identities of their students as well as adapting to shifting curricular, political, and cultural

perspectives on schooling (see, for example, Authors 2022; 2023). Ultimately, our research posits that professional learning and practice that incorporates critical hermeneutic-informed design can help teachers find confidence and meaning in complexity.

Embracing indeterminacy

In this article, we have attempted to describe the challenges and opportunities of teachers' design work for practicing amidst complexity. We emphasised the need to help teachers see the indeterminacy of the situation: indeterminacy in the possible ways to frame a situation and indeterminacy in perceiving the backtalk. This way of working with and interacting with the world leaves space for the designer to make new, often deeply personal, meaning out of situation, even (or perhaps especially) if the situation is embedded in a rapidly shifting context.

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

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

> The optimism associated with design is a **skeptical optimism**. It is an optimism shaped by questions that arise. It is not abstract or naïve. As a process that interweaves thought with action, one receives feedback from the action, and the feedback leads to new questions that expand understanding of the problem space. Thought is grounded through the test of theory hitting the real world. Trying out ideas leads to failures and unexpected new questions, and ultimately to greater depth, breadth, and sophistication of the response. Design activity relies on perpetual skeptical optimism. (p. 26, emphasis in original)

Designers work from a belief that there are limitless ways to interact with a complex situation, even when no clear solutions are in sight. They embrace the complexity, recognise indeterminacy, and seek to temporarily contain it through creating and applying a frame. This allows them to explore, probe and learn, and, hopefully, spur effective change.

Seeing things differently, whether that difference comes from purposefully looking for indeterminacy or because the situation or broader context responds unexpectedly, allows the designer to integrate the complexities of the self, the situation, and the context in a personally meaningful and effective manner. We believe that this is an insight that is important for teachers (and teacher educators) to embrace. It recognises and respects the complexity of the work and context while also providing ways forward that are not simplistic and linear. Educators are inherently about the future, and it is with sceptical optimism, and through the forward-focused lens of design, that we can empower teachers to productively confront complex challenges of teaching and learning.

Note

1. Throughout this section, the use of the first person will refer to the first author who worked directly with the teachers in this study. The second author assisted in conceptualising the study, interpreting the findings, and writing the results.

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