6-7-2021

Chapter 4- Advancing an Approach of Resilient Design for Learning by Designing for Extensibility, Flexibility, and Redundancy

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Recommended Citation

Quintana, R. M., Fortman J., & DeVaney, J. (2021). Advancing an approach for resilient design for learning by designing for extensibility, flexibility, and redundancy. In Thurston, T. N., Lundstrom, K., & González, C. (Eds.), *Resilient pedagogy: Practical teaching strategies to overcome distance, disruption, and distraction* (pp. 77-92). Utah State University. https://doi.org/10.26079/a516-fb24.

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ADVANCING AN APPROACH OF RESILIENT DESIGN FOR LEARNING BY DESIGNING FOR EXTENSIBILITY, FLEXIBILITY, AND REDUNDANCY

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Advancing an Approach of Resilient Design for Learning

The impact of the COVID-19 crisis on educational systems requires actors across those systems to develop adaptive capacity and embed resilient thinking into approaches and frameworks for decision-making and design (DeVaney & Quintana, 2020). Events surrounding the COVID-19 crisis have set off a period of rapid adaptation across the higher-education ecosystem and have necessitated that educators consider new pedagogical approaches and frameworks that are responsive to the changes we are witnessing in our contexts of teaching and learning (Chraa et al., 2020; Donovan, 2020; Moorhouse, 2020; Quintana & Quintana, 2020; Zhu & Liu, 2020).

Instructors at all levels now have a promising opportunity to adopt new learning design approaches that can effectively anticipate and respond to fluctuating conditions and disruptions within instructional environments (Adedoyin & Soykan, 2020; Blankenberger & Wiliams, 2020). At the same time, the current circumstances create opportunities for institutions of higher education and actors to develop adaptive capacity and to embed resilient thinking into decision-making and resource allocation. These efforts can support an enduring transformation and result in both enhanced learning outcomes and risk mitigation across learning environments and academic programs. In this chapter we advance an approach to resilient teaching that focuses on the capacity of instructors to rethink the design of learning experiences based on a nuanced understanding of changing educational contexts. We do so by articulating three guiding principles for resilient design that can be adopted by individual instructors or instructional teams possessing agency. At

the same time, we recognize that the full implications for the widespread adoption of this approach is dependent on other factors, because designing for these contexts is actually a complex systems problem that requires enhancements to the system at the programmatic, institutional, state, national, and global level.

Early in the COVID-19 crisis, educational leaders framed the rapid transition to online instruction as emergency remote teaching (ERT). Hodges et al. (2020) elucidate on this rapid transition:

> ERT is a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances. It involves the use of fully remote teaching solutions for instruction or education that would otherwise be delivered face-to-face or as blended or hybrid courses and that will return to that format once the crisis or emergency has abated. (para. 13)

ERT was initially coined to underscore the temporary and suboptimal conditions instructors and students faced early in the COVID-19 crisis. Yet, even within the early days of the crisis, Moore and Hill (2020) began to outline a possible progression of four phases in higher education's response to the COVID-19 crisis, beginning with ERT, progressing to (re)adding basics into online courses, moving toward an extended period of turmoil, and then finally settling on what these authors characterize as an "emerging new normal."

Coinciding with the articulation of these four potential phases, pedagogues began to advance a new way of framing how instructors could approach pedagogical design in order to withstand the first three phases of the progression outlined by Moore and Hill (2020) and to thrive within the projected "new normal" of teaching and learning in higher-education settings. Now that many instructors have recent practice with ERT and are now operating within the altered teaching landscape, we can draw on their rich experiences to inform and deepen our understanding of resilient teaching approaches. In fact, even if instructors could return to their previous methods and modes of instruction, we posit that lessons learned through the extraordinary period of innovation necessitated by the COVID-19 crisis should ideally be extended to future instructional contexts.

In this chapter, we advance a learning design framework called resilient design for learning (RDL). This framework developed from emerging conversations throughout the higher-education ecosystem, including instructional design circles and academic publications. The ideas presented in this chapter were first developed by the authors of a community-oriented massive open online course (MOOC) that launched on the Coursera platform in June 2020 (Quintana & DeVaney, 2020). The creation of the MOOC was motivated by our perception that although universities mobilized quickly during the emergency remote teaching phase, instructors required approaches that would uphold them beyond the early phases of the crisis brought on by the COVID-19 pandemic. Indeed, at the time of writing this chapter (fall of 2020), it seems that sustainable pedagogical approaches are needed to address challenges faced by instructors throughout the continuing crisis and beyond. At this juncture, we aim to produce a more robust and scholarly account of the approach that we present in the MOOC, drawing from academic literature and disciplinary frameworks. We also highlight responses from learners in the MOOC who reflect on their own experiences and design

intentions within the course's discussion forums, as we believe that their perspectives extend the range of examples we can show to exemplify the framework we present in this chapter.

The RDL framework that we detail in this chapter draws from disciplines that either exemplify resilience themselves (e.g., biology) or utilize ideas related to resilient design (e.g., business management). It is also inspired by ideas about systems thinking (Meadows, 2008) and universal design for learning (UDL; Rose & Meyer, 2002). Systems thinking (Meadows, 2008) helps us consider course design as a set of interconnected elements that are coherently arranged and constructed so as to meet a specified purpose. Furthermore, courses are systems integrated within larger institutional systems, and these systems are interdependent (Bhamra et al., 2011). UDL provides a useful direction for considering learner and environmental variability in designing resilient learning experiences. Thus, RDL synthesizes views of resilience from a range of disciplines, systems thinking, and educational design frameworks in order to articulate three guiding principles: designing for extensibility, designing for flexibility, and designing for redundancy.

While we will expand on these three principles later in the chapter, we provide a high-level overview here. We start with the principle of extensibility, because it allows us to plan for present and future design contexts simultaneously. When designing for extensibility, instructors are able to foresee changes or additions to a course design that may be required or desirable. This design principle is premised on the notion of the "minimum viable product," where an initial version of a course is created with the intention that existing course elements could be extended or added in a systematic and iterative manner. We then move to the principle of flexibility because it encourages instructors to think about how they might practically apply designs for learning, even if the learning environment is different from what was originally expected. When designing for flexibility, instructors are able to anticipate and respond to unfolding changes in a learning environment by attending to variability within the learning environment itself. Here we build on ideas from UDL and posit that this educational framework provides a way of thinking about facilitating interactions in support of learning that are effective and sustainable across multiple environments, even if they must be modified or altered to suit a different context. Finally, we turn to the redundancy principle, which allows instructors to make progress toward longer-term, sustainable goals. When designing for redundancy, instructors first analyze their course design plan to identify components that may be particularly vulnerable and then create components that can perform similar operations and are thus interchangeable. To operationalize the redundancy principle, we return to ideas from UDL and focus on two of its three tenets: multiple means of representation and multiple means of action and expression. Collectively, these three guiding principles represent the ability to reimagine and repurpose complex interactional elements within the design of a course.

Envisioning Resilience in Design

Basic definitions of resilience foreground the capacity of an object or entity to successfully return to its original state in the face of disruption or change. The definition offered by Meadows (2008) encapsulates this idea: Resilience is the "ability to bounce or spring back into shape, position, etc., after being pressed or stretched. Elasticity. The ability to recover strength, spirits, good humor, or any other aspect quickly" (p. 76). This notion of resilience is also exemplified in Aesop's fable of "The Oak and the Reeds," when a storm destroys a mighty rigid oak tree, and the flexible reeds survive because of their ability to accommodate and respond to changing conditions (Aesop, 2018). As we think about expanding capacity for resilience, we should shift from a reactive stance to a more proactive one that anticipates the need to accommodate change. We can perceive times of turbulence and disruption as an opportunity for growth and improvement. We can think of resilience as embodying ideas of flexibility, adaptability, and foresight; for example, Fiksel (2006) defines resilience as "the capacity to survive, adapt, and grow in the face of turbulent change" (p.15).

Within the context of this chapter, we want to emphasize that we are advocating for a definition of resilience that goes beyond attending to the responsiveness of an individual, to cultivating strategies that allow us to design for resilience within systems and institutional contexts. We view adversity as an opportunity for growth and resilience as a characteristic that can be the focus of design efforts. We see connections to Peter Senge's (2006) concept of the learning organization, which he characterized as a place where "people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together" (p. 3). In taking up the ideas of resilient design for learning that we advance in this chapter, we advocate for approaches that move beyond recovery toward a framework that enables more sustainable forms of learning design and teaching, situated within communities of practice (Lave & Wenger, 1991; Quintana & DeVaney, 2020).

Connecting Resilience to Academic Discourses and Disciplines

The notion of resilience has been adopted by a variety of academic discourses and disciplines. Across these domains, systems thinking has emerged as a cross-cutting theme within resilient design. In this section, we will draw on literature from business management, ecology, and biology to showcase how diverse scholars have turned to systems thinking as a foundational principle for resilient design. We will conclude this section by attending to a definition of systems thinking offered in Meadows (2008) and use it as the basis for conceptualizing a basic course system.

Within the field of business management, Fiksel (2015) develops a concept of systems resilience that focuses on the dual characteristics of business connectivity and hierarchy. While business connectivity arises from "strategic partnerships, joint ventures, and extended supply chains," business hierarchy arises from "the structural layers that typify the modern enterprise" such as organizational hierarchies, product hierarchies, and processes hierarchies (p. 39). For Fiksel, systems resilience represents a radical shift in mindset: from business management approaches that tended to focus on discrete things (products, customers, etc.), to the broader systems these things are agents in.

Ecologists have similarly adopted a systems view of resilience. For instance, Walker et al. (2004) define resilience in a social-ecological system as the capacity to "absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (p. 2). They further detail four "crucial aspects" of resilience within a social-ecological system: latitude, resistance, precariousness, and panarchy. In this framework of resilience, latitude characterizes the maximum amount a system can change, resistance characterizes the difficulty of changing a system, precariousness characterizes how close a system is to its breaking point, and panarchy characterizes the relationships between systems of different scale (e.g., macro-scale systems such as global climate change and oppressive politics triggering local systems changes in towns, villages, and regional ecosystems).

Systems thinking has also been taken up in biology, notably in the field of systems biology. While definitions of systems biology are diverse, a general definition offered by the Institute for Systems Biology (2019) states that "It is a holistic approach to deciphering the complexity of biological systems that starts from the understanding that the networks that form the whole of living organisms are more than the sum of their parts" (para. 1). This definition is also well aligned with definitions offered by Korth and Katze (2013) and Westerhoff and Alberghina (2005), as they similarly note that systems biology attempts to understand principles of biology by focusing on interactions among biological elements. The Institute for Systems Biology (2019) further notes that the field is largely concerned with predicting systemic change and developing "solutions to the world's most pressing health and environmental issues" (para. 1). The notion that systems biologists would work toward predicting systemic change as a means of developing solutions toward pressing problems neatly aligns with our previous notion of a resilient design, which similarly underscores the need to anticipate changes in dynamic contexts.

For instructors and course designers, the notion of resilient system design advanced by scholars from business management, ecology, and biology highlights the importance of thinking systematically, contextually, and hierarchically within a resilient design for learning. Rather than looking at a learning environment as a collection of discrete objects, these scholars prompt us to think about the ways in which students, instructors, curriculum, assessments, activities, and sociopolitical landscapes necessarily inform each other within complex, hierarchical systems.

To further develop the connection between systems thinking and course design, we can also turn to Meadows (2008), who proposes that systems are "an interconnected set of elements that is coherently organized in a way that achieves something" (p. 12). The three essential elements that comprise systems in Meadows's definition can also be applied to learning environments: purpose, elements, and interconnections. Beginning with purpose (as purpose often defines many of the elements of a course), a course is designed to fulfill stakeholders' goals (institution, students, instructor) and its design is guided by a set of learning goals or intended learning outcomes that are usually articulated by the instructor (Wiggins & McTighe, 2005). To identify course elements, instructors and course designers would likely focus on aspects such as course topics, course readings, lectures, and activities. Finally, the instructor or course designer should consider the interconnections they want to foster that enable the course to function by connecting those different course elements to the purpose of the course. Designing a course then involves simultaneously considering the purpose, elements, and interconnections (interactions) that make up a course.

The Resilient Design for Learning Framework

Having drawn on a diverse selection of disciplines to envision an RDL predicated on systems thinking, we now turn toward articulating and expanding on three guiding principles of RDL. These guiding principles are intended to serve as foundational ideas for instructors and course designers as they seek to design learning experiences that are capable of adapting to fluctuating change.

First Guiding Principle: Designing for Extensibility

The first guiding principle of the RDL framework is extensibility. We draw on ideas from software systems design that define extensibility as "the capability of a software system to enable the implementation of extensions to expand or enhance the system with new capabilities and features with minimal impact to the existing system" (Bode & Riebisch, 2010, p.184). When designing courses with the extensibility principle in mind, instructors and course designers should endeavor to foresee additions or changes to a course design that may be required or desirable. When considering additions or changes that might be *required*, instructors should attend to the situational factors of their course (Fink, 2013) such as number of students, course level (i.e., undergraduate or graduate), length and frequency of class meetings, and mode of instruction (e.g., face-to-face, online, hybrid). Within the context of COVID-19, instructors might especially anticipate shifts in modes of instruction due to the rapid changes in circumstances surrounding the spread of the virus. When considering changes or additions that might be *desirable*, instructors should attend to aspects of their course design that they would ideally like to develop but are not currently able to due to impediments such as time or resource constraints.

In considering what it means to design for extensibility, one helpful construct can be borrowed from the startup world—that of the minimum viable product (MVP; Müller & Thoring, 2012). While some pedagogues might be suspicious of the entrepreneurial undertones of the MVP, the basic concept can be helpful when thinking about course design and development. We can think of the MVP as the most basic version of some product that would minimally fulfill enough of the purpose that it could be released to the public. In the context of course design, the goal of the MVP is to ensure that a well-designed (although perhaps lean) version of a course is offered that will allow students to make progress toward learning goals that the instructor has articulated.

Another helpful framing for extensible design might be to adopt goals associated with designing for meaningful learning experiences (Fink, 2013) and ask, "What is the special pedagogical challenge of the course?" (p. 80). Relatedly, Sobel et al. (2009) recommended that instructors locate the central problem of a course and develop corresponding manageable units of instruction. From there, instructors can consider incorporating elements that enhance the original aspects of the course design.

The MVP also provides instructors with a point of reference for evaluating the first iteration of a course design, which can be used as a foundation for future improvements (Hodges & Fowler, 2020). After a course design is established that includes a set of elements that work together to enable desired interactions that support learning goals across current and future contexts, we can consider two additional facets: (a) increasing the *capacity* of existing elements and/or (b) adding entirely new elements. These "extensions" should be used in support of strengthening existing interactions or creating *new ways* of supporting interactions in support of learning (Cohen et al., 2003). Thus, instructors could systematically grow the MVP version of a course through careful refinement, adding well-conceived, well-constructed, and well-managed elements. These additions can be added, and changes can be made piece by piece, with adjustments only made if new and altered course elements align with established learning goals.

When operationalizing the extensibility principle, it is essential to be able to hold two design contexts in view simultaneously—the present context and an anticipated future context. The idea is to create a course design that will allow and accommodate changes. In other words, extensible courses are the opposite of brittle ones. If courses are designed from the outset with the intent that they are likely to be modified in some way, future alterations should not fundamentally damage the course design. While the first version of a course might be thought of as the MVP, instructors and course designers should simultaneously design the initial version of the course with a future version of the course in mind. It is important that instructors and course designers have both views in mind concurrently in order to create MVPs that are readily extensible, serving as suitable building blocks for future design efforts.

Participants in our Resilient Teaching Through Times of Crisis and Change MOOC articulated how they were using the extensibility principle to think about an MVP version of a course, while simultaneously considering how they might alter and improve their course designs in the future. One participant stated that

their MVP plan was to develop a set of short videos with corresponding multiple-choice quizzes. Their design was extensible because they intended to subsequently develop synchronous activities to complement these resources and assessments. The structure of these activities could be tailored to the learning context, whether the course is held in person or online. Another participant similarly suggested that their plan was to create a set of short videos as their MVP, with the intention of utilizing a video player that allows for annotation and interaction between the instructor and students. The videos could initially stand on their own as media resources; then the instructor could create an activity that asks students to view the videos using a player that allows students to add written reflections at specified moments within the video. Yet another participant articulated that the extensibility principle allows them to make progress toward advancing goals related to inclusivity and diversity by allowing them to offer an initial set of examples that will be expanded to include a wider range of perspectives and ideas. These participants simultaneously considered their current design context and available time and resources to envision how an initial MVP could serve as the foundation for future iterations. These anticipated changes and additions should be easily integrated because the original design was made to accommodate them.

Second Guiding Principle: Guiding for Flexibility

The second guiding principle of the RDL framework is designing for *flexibility*. When designing for flexibility, instructors should cultivate and apply strategies for responding to unfolding changes in a learning environment by attending to variability within the learning environment itself. These changes might be anticipated or unanticipated. Here we build on ideas from universal design for learning (UDL) and suggest that this framework provides a way of thinking about facilitating interactions in support of learning that are effective and sustainable across multiple environments, even if they must be modified or altered to suit a different context.

Developed at the Center for Applied Special Technology by David Rose and colleagues, UDL builds on ideas from universal design and extends them to designs for learning within K–12 contexts (Bowe, 2000; Johnson & Fox, 2003; Orkwis & McLane, 1998). At its most basic level, the UDL framework is organized according to a "why," "what," and "how" structure. The "why" relates to the importance of keeping students engaged to advance their learning, the "what" is through multiple means of representation, and the "how" is through multiple means of expression and action (Center for Applied Special Technology [CAST], 2018). The three main tenets of UDL are multiple means of engagement (related to interactions and motivation), representation (content), and action and expression (assignments and assessments).

UDL posits that designing for learner variability—even before instructors know their students personally—is the most effective way of reducing individual accommodation needs. "UDL is a way of thinking about the interactions that we have with our learners so that they do not have to ask for special treatment, regardless of the types of barriers that they face—time, connectivity, or disability" (Tobin & Behling, 2018, p. 130). The

flexibility principle builds on these ideas and suggests that designing for variability within the learning environment itself is the most effective way of ensuring that course designs can adapt and respond to disruption or changes in learning contexts. As instructors think about their course designs, they might need to consider a range of contexts or circumstances in which they will teach their courses. Then, as they think about the different interactions they want to support, they can think about complementary strategies as alternatives that they can adopt to facilitate desired interactions within a range of circumstances.

The original intent of UDL was to focus on increasing access for all students, including those with disabilities (Hitchcock et al., 2002; King-Sears, 2009). However, the framework gained traction in broader contexts and application areas, including in institutions of higher education where instructors and designers are thinking about students who may be accessing courses with a focus on mobile devices and online settings (Tobin & Behling, 2018). The flexibility principle is most closely related to the first tenet of UDL: multiple means of engagement, which pays particular attention to how students engage with each other, instructional content, and the instructor. Another way of thinking about this idea is by paying attention to how interactions are supported. As instructors think about designing interactions in support of learning, they consider how they will facilitate interactions such as how students will interact with other students; how students will interact with content; and how students and instructors will interact with each other (Cohen et al., 2003; Hart-Davidson, 2020). As instructors and course designers anticipate that learning environments will change (with varying degrees of fluctuation), they must give thought to how they will be able to continue to facilitate desired interactions, even if the means of supporting these interactions must be adjusted. When planning for and enacting the flexibility principle, instructors and course designers will need to keep the unique context of their course in mind, including important situational factors that are related to the teaching and learning situation (Fink, 2013).

Although designing for flexibility might seem like a new requirement necessitated by the COVID-19 crisis, in reality, educators have long dealt with unpredictability with respect to their teaching contexts and have had to adjust accordingly. For example, instructors have commonly coped with some uncertainty around student characteristics and situational factors (e.g., class size, classroom configuration). Before a course begins, instructors likely know very little about the characteristics and needs of their individual students. Thus, instructors have had to design courses based on assumptions about what their students would be like, such as students' motivations for taking the course, their background knowledge and relevant experiences coming into the course, and how they would likely engage with the material. They might base their understanding of what future students would be like on their previous teaching experience, wisdom from the literature, or advice from colleagues. Then, throughout the semester, they could adjust their teaching approaches if student characteristics were different than expected. Similarly, instructors have had to plan their courses based on their current understanding of situational factors (e.g., class size, classroom configurations), with the knowledge that these characteristics could change after a course has started. Now, with the uncertainty surrounding what higher-education learning environments will look like in the future, instructors will need to be even more

intentional about designing with a wide range of contextual factors in mind. They will need to plan for the "unknown" learning environment in addition to the learners they have not yet met. Furthermore, instructors will need to make a plan of action for how they will implement various contingencies that they have identified.

Participants in our Resilient Teaching Through Times of Crisis and Change MOOC discussed how designing for environmental variability could allow them to realize positive learning outcomes and advance learning in the face of normal conditions, minor disruptions, and different types of crises. Participants articulated that implementation of the flexibility principle allowed them to invest a lot of mental effort and time in advance, which they anticipated would allow them to more fluidly apply their plans if minor or major disruptions occur. Additionally, these educators saw benefit in being able to respond to variability in their students' interests and needs, having already created a range of options for implementation. Participants noted that their ability to respond to their students' needs (e.g., broadband capacity) increased when they had already given consideration to the potential for variability within students' remote learning environments and how these differences could influence their students' experience of a course. Thus, by designing for redundancy, participants would be able to anticipate and then enact necessary changes to their course design based on a close reading of the shifting contexts of their instructional environments.

Third Guiding Principle: Designing for Redundancy

The third guiding principle of the RDL framework is designing for *redundancy*. When instructors and course designers design for redundancy, they look for alternative ways of accomplishing a given instructional goal in case any disruption to their instructional environment forces them to remove one or more elements from their course plan. They might first look for areas where course plans might be "brittle" and vulnerable. Another way to think about this is to identify what one could call "single points of failure"—an aspect of a course design on which the success of the course hinges. Once these vulnerabilities have been identified, instructors can develop "backups" or contingencies that will allow the course to recover from the potential failure of one or more course elements or instructional strategies. The idea behind designing for redundancy is that if one or more course elements fail, the interactions that instructors have designed for can still be facilitated, albeit in alternative ways. The redundancy principle is related to the idea of structural resilience. A system of distributed electric generators (e.g., fuel cells) connected to a power grid is more resilient to disruption than a central power station (Fiksel, 2015). Similarly, a system of geographically distributed workers linked by telecommunications technologies could be more impervious to catastrophic events than a group of colocated workers (Fiksel, 2015). By creating redundant course elements (i.e., backups), instructors can ensure that their course system is relatively stable and less likely to fail if disruptions occur.

The redundancy principle can be operationalized by once again attending to ideas from UDL, specifically tenets two and three: multiple means of representation, and multiple means of action and expression. First, as

we examine multiple means of representation, we consider that students differ in the ways they perceive and comprehend information (Rose et al., 2006). The goal here is for instructors to evaluate how information is represented within their course and how presentation of content could be potentially diversified. Providing multiple means of representation is helpful to learners who may prefer one format over another and could potentially ensure that students do not fall behind (i.e., if a given single-stream format is not well-suited to particular students). Second, as instructors and course designers attend to multiple means of action and expression, they acknowledge that besides providing students with various ways of acquiring information and knowledge, it is equally important to offer students alternatives for demonstrating what they have learned. For example, instructors could encourage students to solve problems using a variety of strategies and be flexible in assignment submission formats. The key is not to assess the form of expression, but rather to assess how students are able to demonstrate and apply knowledge, connected to course learning goals.

Thinking about developing alternatives for course elements can be daunting and overwhelming. In response to this reality, Tobin and Behling (2018) advanced a "plus one" approach, in which they advocate that instructors should *incrementally* and *systematically* add content, assignments, and assessments in alternative formats to their repertoire of course resources. "By adopting this plus-one mindset, UDL becomes a process of identifying the areas of greatest need, based on their previous experiences, and addressing those needs in order to keep students motivated, on task, and learning" (Tobin & Behling, 2018, p. 136). As we have already discussed, instructors can begin by examining their course design for areas of vulnerability and focus on materials or approaches that shore up those areas. Specifically, instructors could ask: "What components of the course rely on single-stream materials?" (i.e., materials provided in one format). Instructors could also ask: "What assessment types are implemented using a single format?" (e.g., multiple choice quiz, written reflections). For each area that is identified, instructors can begin to develop one additional means of representation or action and expression. This is the "plus one" approach. The idea is that over time, instructors can gradually build up a set of materials that support multiple means of representation (in presentation of content) and action and expression (through assignments and assessments). Although the premise of UDL is to support a wide variety of learners to the greatest extent possible, we can see that following these guidelines actually allows instructors to design for redundancy. If one of the means of representation or expression fails, then an alternative format that has already been identified or created can be used instead. By minimizing dependence on certain tools or activities, the course will still largely function, even if original course elements fail or are lost due to a disruption.

Participants in our Resilient Teaching Through Times of Crisis and Change MOOC shared insights on how they have operationalized the redundancy principle by first identifying aspects of their course that are the most brittle and then by taking steps to address these vulnerabilities by creating multiple, viable alternatives. Participants identified unstable aspects of their course designs, such as exclusive reliance on synchronous lectures and discussions, as not all students will have access to high-speed internet and a quiet learning environment. To remediate this weakness, instructors planned to prepare lectures in multiple formats (e.g.,

video recordings, written scripts), and create backups of lectures that are delivered synchronously (i.e., file uploads), so that students can access them should their technology fail or if they are absent. Some participants noted that their original course design relied on written tests, but intended to include multiple means of evaluation such as online quizzes, individual and collaborative projects, and oral online examinations.

Conclusion

In this chapter, we have outlined a framework for RDL based on three guiding principles: designing for extensibility, designing for flexibility, and designing for redundancy. We view these three guiding principles as reciprocal, reinforcing, and giving shape to a learning design framework that can be applied and (re)interpreted across learning contexts. The adaptability of these principles stem from a more general course design approach that seeks to understand learning experiences as systems. While systems thinking has been adopted by a diversity of other fields, for educators and course designers, this turn toward systems thinking represents an opportunity to see resilience in teaching and course design.

Born out of the COVID-19 pandemic, the RDL framework charts a vision for resilient teaching beyond our current circumstances. We posit that an aspirational vision for resilient teaching can be summarized as follows:

> Resilient teaching is the ability to facilitate learning experiences that are designed to be adaptable to fluctuating conditions and disruptions. This teaching ability can be seen as an outcome of a design approach that attends to the relationship between learning goals and activities, and the environments they are situated in. Resilient teaching approaches take into account how a dynamic learning context may require new forms of interactions between teachers, students, content, and tools. Additionally, they necessitate the capacity to rethink the design of learning experiences based on a nuanced understanding of context.

Future learning environments in higher education require instructors at all levels to be even more intentional about designing with a wide range of contexts and potential disruptions in mind. As we look ahead and attempt to understand what these future learning environments will look like, we know even our best predictions are plagued with uncertainty. However, this uncertainty for the future only motivates the need to advance a resilient design approach that builds capacity for the unpredictable. It is this uncertainty that asks instructors of all levels to be intentional about designing for change and disruption. And it is this uncertainty that asks the system of higher education to develop adaptive capacity and to embed resilient thinking into decision-making and resource allocation to support an enduring transformation.

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