Instructors' conceptualization and implementation of scaffolding in online higher education courses

Jennifer C. Richardson¹ · Secil Caskurlu² · Daniela Castellanos-Reyes^{1,3} · Suzhen Duan^{1,4} · Mohammad Shams Ud Duha^{1,5} · Holly Fiock^{1,6} · Yishi Long^{1,7}

Accepted: 15 October 2021 / Published online: 1 November 2021
© The Author(s) 2021

Abstract

This multiple case study explores how instructors conceptualize and employ scaffolding in online courses. Participants included full time faculty ($n=4$) who have designed and taught at least one online course within the past 12 months. Data sources included pre-interview surveys, semi-structured interviews, and online course observations. Data were analyzed by employing a general analytical strategy for developing a case description (Yin, 2018). The results showed that (a) instructors define scaffolding as a support to help students achieve course outcomes and (b) instructors implement different types of scaffolding (i.e., conceptual, metacognitive, procedural, strategic, and motivational) in hard and soft scaffolding forms. The results also showed that instructors' conceptualization and implementation of scaffolding differed based on their discipline and teaching philosophy, and the unique features of online courses. Implications for practice and research are discussed.

Keywords Online learning · Scaffolding · Scaffolding in higher education · Case study

Introduction

Online courses around the globe continue to increase due to their flexibility and convenience, including working at a preferred pace, accessing various resources and courses, and providing affordable educational opportunities (Davidson-Shivers et al., 2018). For instance, according to the National Center for Education Statistics (2019), the percentage of learners enrolled in any online course went up 2.9% from fall 2016 to fall 2017; and the percentage exclusively enrolled in online courses increased from 12.8 to 32.9%. Despite the significant growth in online education, student attrition is higher in online courses than in face-to-face courses (Darby &

✉ Jennifer C. Richardson
jennrich@purdue.edu

Extended author information available on the last page of the article

Lang, 2019). Attrition occurs because students face multiple challenges from familiarizing themselves with the online environment to lack of just-in-time instructor support or social support from their peers (Darby & Lang, 2019). Therefore, providing scaffolding is crucial in online courses to sustain students' interest and overcome the challenges, which will in turn help students achieve their learning objectives. The concept of scaffolding emanates from the field of early childhood development (Wood et al., 1976); however, scaffolding quickly started being used in K-12 environments (Belland, 2014; Many, 2002; Mertzman, 2008) and higher educational settings (Bannert et al., 2009; Pifarre & Cobos, 2010; Reingold et al., 2008). Earlier research on scaffolding in online learning has shown that scaffolding supports students' confidence with the task (e.g., Oh & Kim, 2016), metacognition skills (e.g., Kim & Lim, 2019), motivation and self-regulation (e.g., Gormley et al., 2012), and engagement (e.g., Cho & Cho, 2016; Smallwood & Brunner, 2017). Yet, research on how instructors conceptualize scaffolding and what their scaffolding practices look like in their online courses is lacking. Therefore, this multiple case study aims to explore how instructors conceptualize and apply scaffolding in their online courses in a higher education setting.

Scaffolding as a framework

Scaffolding has been traditionally characterized as a supportive process to enhance student learning. The metaphor for *scaffolding* in learning was first developed by Wood et al. (1976) during their studies examining the role of tutoring in children's problem-solving. They defined scaffolding as "a process that enables a child or novice to solve a problem, carry out a task, or achieve a goal which would be beyond his unassisted efforts" (Wood et al., 1976, p. 90). While Wood and colleagues (1976) performed the earliest study on scaffolding on children from 3 to 5 years old, Pea (2004) explained that the concept of scaffolding could be applied across complex cognitive learning processes, addressing a strong conceptual connection between scaffolding and Vygotsky's (1978) concept of the zone of proximal development (ZPD). From Vygotsky's ZPD perspective, scaffolding is essential for learners' cognitive learning processes from the level of what they cannot do to what they can do by receiving support from instructors or more experienced peers. With that in mind, learners are affected by previous experiences and the environment to which they were exposed (Pea, 2004). As Reiser and Tabak (2014) explain, "Scaffolding enables not only the performance of a task more complex than the learner could handle alone, but also enables learning from that experience" (p. 45).

Further, scaffolding as Pea (2004) explained, can be considered both as a noun and as a verb. As a noun, Pea (2004) explained that scaffolding is a *structure* that temporarily guides learners to perform activities beyond their capabilities and is later removed when learners achieve independent proficiency. As a verb, scaffolding is a *process* that occurs over time, and until learners achieve autonomous performance. For the purpose of this study, we defined scaffolding as the process through which learning efforts are supported; scaffolding happens when a more knowledgeable other helps a learner to perform certain tasks until the learner can do

it independently (Glazewski & Hmelo-Silver, 2019; Reiser & Tabak, 2014; Wood et al., 1976).

Types of scaffolding

Scaffolding can vary depending on the type of guidance provided to students (Shin et al., 2017). Brush and Saye (2002) proposed two forms of scaffolds—hard and soft. Hard scaffolds are typically fixed and technology-based, which can be planned in anticipation of potential difficulties of a learning task (Sharma & Hannafin, 2007). These scaffolds are commonly used to support general needs and can be embedded within learning environments (Brush & Saye, 2002; Simons & Klein, 2007). For example, hard scaffolds can be designed to provide background information when an instructor predicts that learners may be unfamiliar with specific concepts. In contrast, soft scaffolds are dynamic, customized, and situation-specific aids provided by a more knowledgeable other to help with a learning task (Brush & Saye, 2002; Shin et al., 2017). An example of a soft scaffold would be providing learners with personalized, just-in-time feedback on a project. Sawyer (2011) suggested that both hard and soft scaffolds should be selected wisely; otherwise, learners can be overwhelmed or under-challenged, which makes them lose interest in instructional activities. Moreover, Pea's (2004) work echoed the idea that social and technological aspects have come together in scaffolding gradually.

In the online learning environment, the use of Hannafin et al. (1999) and Belland et al.'s (2013) scaffolding classifications help conceptualize scaffolding as they differentiate between scaffolding mechanisms and types. Scaffolding mechanisms are the methods through which scaffolding is provided; for example, techniques such as modeling, advanced organizers, concept mapping, or knowledge transfer, and can include resources and tools. In this study, we focused on five types of scaffolding: conceptual, metacognitive, procedural, strategic (Hannafin et al., 1999), and motivation (Belland et al., 2013) as our framework:

- Conceptual scaffolding “guides learners in what to consider” (p. 131) when a problem is given (Hannafin et al., 1999). It focuses on conceptual knowledge, tackling learners’ misconceptions, showing relationships among concepts, or providing hints to learners (Hannafin et al., 1999). Study guides, outlines, advanced organizers, concept maps (Stavredes, 2011), and specific learning objectives (Smallwood & Brunner, 2017) are example mechanisms for conceptual scaffolding.
- Metacognitive scaffolding focuses on the thinking process when solving problems (Hannafin et al., 1999). It could focus on domain specific problems or be general if the context is unknown. Domain specific metacognitive scaffolding asks about specific features of the problem, unlike general metacognitive scaffolding that seeks to link learners’ prior knowledge and experiences to the problem to solve (Hannafin et al., 1999). Examples of metacognitive mechanisms are reflections, worked examples, course overviews (Stavredes, 2011), and assignment grading rubric with external resources (Smallwood & Brunner, 2017).

- Procedural scaffolding guides learners with the use of available resources and tools (Hannafin et al., 1999). It refers to just-in-time resources and help that learners need to navigate online learning environments (Stavredes, 2011). Examples of procedural scaffoldings are course orientations, communicating expectations to learners at the beginning of the course (Stavredes, 2011), and tips and suggestions for online communication (Smallwood & Brunner, 2017)
- Strategic scaffolding provides learners with multiple and alternative approaches to solve a problem (Hannafin et al., 1999; Stavredes & Herder, 2015). Strategic scaffolding serves to meet “the diverse needs of learners” by providing alternative explanations, probing questions, supplementary resources during the learning experience (Stavredes, 2011, p. 101), and formative feedback on assignment drafts (Smallwood & Brunner, 2017).
- Motivational scaffolding guides learners to deploy effort toward learning goals and persist in a learning task (Bellant et al., 2013). Promoting mastery goals, regulation of emotions, autonomy, and expectancy for success are some of the methods used to support motivational scaffolding. Instructors can support motivational scaffolding by prompting learners to choose aspects of a problem they want to explore and investigate (Palmer, 2009).

Scaffolding is “all about providing the right amount of structure in a learning environment, keeping in mind that some learners may require little or no structure and others may require a lot of structure” (Dabbagh, 2003, p. 40). In other words, instructors should select the type and amount of scaffolding purposefully and consider student characteristics (e.g., prior knowledge, motivation), learning task (e.g., complexity, ill-structured, process oriented), and teaching context (Dabbagh, 2003). Additionally, scaffolding should be decreased over time, or faded, as learner’s knowledge, skills, and confidence to complete the task independently increases (Dabbagh, 2003; van de Pol et al., 2010). Fading is necessary to transfer the responsibility of learning to students and increase students’ control of their learning (van de Pol et al., 2010).

Research on scaffolding in online learning environments

With the boom of distance learning (Seaman et al., 2018) in the past decade, the use of scaffolding in online education has attracted considerable attention. While the principles underpinning scaffolding are the same in online and face-to-face learning environments, due to the absence of face-to-face teacher-student and student–student interactions, scaffolding in online learning requires teachers to transform their role from content deliverer to both facilitator and co-participant in learning activities, thereby altering how scaffolding is employed (Dabbagh, 2003). Online instructors use scaffolding strategies in numerous ways (e.g., announcements, course content, discussions, resources, etc.). When looking to implement scaffolding, Sharma and Hannafin (2005) explain.

In practice, these constructs translate into three activities: clearly establishing the goal of the activity at the beginning, continuously negotiating and refin-

ing the goal, and using support and communication strategies that enable both learner and expert to reach the goal (pp. 19–20).

Research on scaffolding in online learning has demonstrated that scaffolding supports students' learning (e.g., Darby & Lang, 2019; Giacumo & Savenye, 2020; Holden & Sinatra, 2014; Reiser, 2004), confidence with the task (Oh & Kim, 2016), problem-solving and meta-cognitive skills (e.g., Kim & Lim, 2019), motivation (e.g., Gormley et al., 2012), academic engagement (e.g., Cho & Cho, 2014), and participation in online courses (e.g., Oh & Kim, 2016).

For instance, Giacumo and Savenye (2020) found that hard scaffolds like analytical rubrics can significantly enhance students' performance of critical thinking skills in an asynchronous learning environment. Within online discussions, scaffolding helps students develop higher thinking skills (Oh & Kim, 2016). Similarly, Oh and Kim (2016) found that audio-based hard scaffolds using VoiceThread facilitated students' higher order thinking skills and cognitive engagement. After investigating the effect of supportive (domain knowledge) and reflective scaffolding (meta-cognitive thinking) on student learning, Kim and Lim (2019) came to the conclusion that the reflective scaffolding group did better in problem solving and demonstrated higher achievement than the supportive scaffolding group. As noted by Gormley et al. (2012), scaffolding can be combined with ARCS Motivational Theory to help students achieve learning outcomes and enhance intrinsic motivation. Similarly, Cho and Cho (2014) found that instructors' scaffolding for interaction influenced students' behavioral and emotional engagement positively in an online environment.

Despite its effectiveness, conceptualization and measurement of scaffolding still remain fluid (van de Pol et al., 2010) due to the various scaffolding definitions and conceptualizations available (Belland et al., 2017; Holden & Sinatra, 2014), especially as it concerns online education and the higher education setting. Therefore, this multiple case study aims to explore how instructors conceptualize and employ scaffolding in their online courses in a higher education setting. Our research question was: How do instructors conceptualize and employ scaffolding in online higher education courses? More specifically,

1. How do instructors conceptualize scaffolding in online environments?
2. What do instructors scaffolding practices look like in their online courses and how they evaluate their scaffolding practices?

Methods

Design of the study

This study used a multiple-case study exploratory design (Yin, 2014) to investigate how higher education instructors conceptualize and employ scaffolding in their online courses. Yin (2014) explains that researchers use case studies to gain a deep understanding of a phenomenon and how individuals experience it in a real-world

context. A multiple-case study approach provides more evidence and makes our insights more robust by allowing us to understand scaffolding from multiple perspectives. We used the case study description technique (Yin, 2014) guided by Hannafin et al.'s (1999) scaffolding framework in online learning environments with insights from Belland et al. (2013), which allowed us to categorize patterns and understand them in relation to the phenomenon.

Context and participants

The data were collected from a large Midwestern R1 public university. Participants were recruited from across campus to share their experiences. To participate in the study, instructors must have designed and taught an online course within the past 12 months. Participants were recruited through several campus-wide program initiatives, however only faculty from within the College of Education responded to the call for participants. All participants ($n=4$) were full time faculty at the Assistant Professor level and therefore considered to be early career. Each instructor was considered as a case. Table 1 summarizes participants' backgrounds; pseudonyms were assigned.

Data sources

To achieve triangulation, we collected three types of data from each participant: pre-interview surveys, semi-structured interviews, and online course observations. Each source was based on the Scaffolding Glossary created for internal use by the research team to ensure a shared understanding of codes, terms, scaffolding types and methods with examples provided for each (see "Appendix A"). Human subject concerns were addressed through approval from the Institutional Review Board (IRB).

Pre-interview survey

Participants received a pre-interview Qualtrics survey link via email to collect information about their background, teaching, and scaffolding practices to screen for eligibility and allow researchers to build rapport during the interview. For example, questions focused on participants' experience teaching and designing online courses,

Table 1 Participant Information

Name	Discipline	Years Teaching (K-12)	Years Teaching (Higher Ed.)	Years Teaching (Online)
Sarah	Mathematics Education	6–10	6–10	1–2
Elaina	Educational Technology	3–5	10+	10+
Cora	Gifted and Talented Education	10+	3–5	3–5
Sam	English Language Learning	1–2	10+	1–2

their teaching philosophy, and how they think learners learn. Participants were also given examples of the five types of scaffolding being investigated and asked whether they used them in their online courses, based on an abbreviated version of the research team's Scaffolding Glossary (only terms, scaffolding types, and methods).

Semi-structured interviews

We used semi-structured interviews to obtain a deep understanding of instructors' perceptions and beliefs about scaffolding (see "[Appendix B](#)"). Prior to the interview, participants received a copy of the interview protocol along with the abbreviated version of the research team's Scaffolding Glossary. The interview protocol was divided into seven sections: (1) conceptualization of scaffolding, (2) designing and implementing scaffolds, (3) types of scaffolds, (4) scaffolding variations, (5) learners' outcomes, (6) challenges, and (7) tools.

Interviews were conducted via video conferencing, lasting between 60 and 90 min, with two researchers participating in each interview. Recordings were transcribed verbatim. As part of the interview, participants were asked to share sample scaffolds via email or screen sharing during the session and provide access to a recent online course.

Online course observations

Observations are critical to providing evidence on the actual application of the phenomenon studied (Yin, 2014). In our research, course observations and artifacts (i.e., announcements, videos, assignments) from the archived online courses were used to gather information on the use of scaffolding in participant's most recent online courses (spring 2020) with the intention to gather examples of each type of identified scaffolding, not to count or quantify each type. The observation protocol was designed based on our theoretical framework (Belland et al., 2013; Brush & Saye, 2002; Hannafin et al., 1999) and contained the components of the research team's Scaffolding Glossary. Observation data were documented by one researcher and checked by a second researcher for accuracy of data examples and coding.

Data analysis

We analyzed the data by employing a general analytical strategy for developing a case description (Yin, 2018). Our data analysis included two cycles of coding (Saldaña, 2016) at the sentence level to avoid data loss. In the first cycle of coding, we used exploratory coding methods and generated a provisional coding schema based on the five types of scaffolding, which we used in conjunction with holistic (macro-level) and in vivo (natural) coding (Saldaña, 2016). Our in vivo coding led to additional codes being added to our schema, including: (1) use of socio-emotional scaffolds in which instructors established emotional connections between the instructor and the learners and among learners, and (2) scaffolding variation using differentiation; differentiated scaffolding emerged when instructors' scaffolding

efforts were modified based on learners' individual needs (e.g., mixed group classes).

In the second cycle of coding, we revised the codes to identify categories and then themes across cases to integrate findings and achieve analytic generalization (Yin, 2014). To do so, we followed two sub steps in the second cycle of coding according to Yin's development of a case description: (1) compared content within themes, (2) identified the descriptive topics (themes and patterns) to create a descriptive framework to organize cases. Next, we developed case descriptions based on the descriptive framework. Finally, we did cross-case analyses across individual cases to allow for a more holistic picture of how online instructors conceptualize and employ scaffolding in their online courses (Yin, 2014). Data were analyzed using NVivo 12 software. Sample codes can be located within the research team's Scaffolding Glossary (see "Appendix A").

Reliability and validity

The interview and observation protocols were piloted with experts in online teaching and scaffolding to establish reliability. All instruments went through two rounds of pilot testing, and changes were made based on pilot feedback. Through this iterative process, face validity was established. We collected multiple sources of data from each participant to achieve data triangulation and increase credibility and trustworthiness (Yin, 2014). Multiple researchers were used during the data collection and coding process for interviews and online course observations for consistency and investigator triangulation (Yin, 2014, 2018). Regular research meetings were established to discuss questions and coding disagreements to achieve consensus. Coders achieved a 99.81% weighted percentage of agreement and an overall weighted Kappa coefficient of 0.91 after consensus building.

Furthermore, during these meetings the researchers' engaged in reflexivity and acknowledged their familiarity with teaching and designing online courses could present bias in the study (Yin, 2018), and an audit trail was maintained to keep track of decisions made and questions to revisit. Constant reviewing helped researchers to conceptualize scaffolding in online learning as understood by participants rather than researchers a priori assumptions (Neuman, 2014). Some participants were asked follow-up questions via email to ensure we were interpreting their perceptions correctly. Member-checking was incorporated once draft results and discussion were available which further contributed to construct validity (Yin, 2014).

Results

The results for our four case studies are presented beginning with a brief description of each case, or participant's background, then sharing our findings for each descriptive topic as they relate to our research questions. Hard and soft scaffolding examples from participant's courses are highlighted for each case. We conclude with a case summary. Cross case analysis is presented within the discussion section.

Sam's case description

Sam has over 10 years of teaching experience in higher education and K-12. Sam had taught 3–5 online courses in the past two years. While Sam first learned about scaffolding in their undergraduate program, they were exposed to the construct further through professional experiences as a teacher going to conferences, attending workshops, and offering workshops.

Conceptualization of scaffolding

Sam defines scaffolding as support to “get students to be able to do what they cannot do by themselves.” Further, Sam mentioned the integration of scaffolding within their area, literacy and language, as types that differed from those we had provided:

We're looking into more, like, visual scaffolding, linguistic types of scaffolding. More like grouping configurations in terms of pairing students up, putting students in groups, for example. And the use of different organizers, like different web organizers that we use in Microsoft Word, for example.

When asked about the difference between general resources and scaffolding, Sam indicated that scaffolding is flexible and adaptable depending on students and the need to “constantly adjust the types of scaffold as you learn from a student and about a student.” Additionally, during the interview, Sam mentioned using both hard and soft scaffolds in their online courses and explained how they differentiate them:

Hard scaffolds come into play during the designing stage of the course and an example is the rubrics that show expectations for assignments and a lesson plan template. Soft scaffolds come about when you have that immediate information that feeds into your decision making when you make it at that moment you are with the students.

Instructor's process for designing and developing scaffolding

When discussing the implementation of scaffolding, Sam mentioned they differentiate their scaffolding practice based on students' needs and *fading* it as students build an understanding of the concept:

We use the literal concept of a scaffold in a building construction, and then see how the purpose of scaffold is actually, from the beginning, to provide support to a construction. But eventually it's all removed and the building is basically on its own, and how we apply that into a classroom or teaching and learning process, and see how different types of support could be used with students.

As for their scaffolding practice, Sam mentioned they use weekly modules, broken into two parts each week. The ‘Ask the Instructor/Ask a peer’ discussion board is always open, while weekly modules open one week in advance. For announcements, they use a bi-weekly format to provide learners with feedback and highlights

as they move into the next week. Furthermore, they consider what supports a student may need for the different assignments, and provide a space for peer interaction to share their understanding of the course material.

Implementation and evaluation of scaffolding

Aligning with what they shared in the interview, we observed both hard and soft scaffolding practices within Sam's course for all five types of scaffolding strategies our study was investigating. Table 2 includes examples from our course observation for Sam and the corresponding types and methods from the literature based on our framework (see "Appendix A" the research team's Scaffolding Glossary for relevant literature). In terms of scaffolding tools, Sam mentioned VoiceThread throughout their interview, especially within discussion boards for interaction and to "see what student are understanding during that week when you interact with student, and there is a room for you to go in and record yourself in terms of the types of support that student needs". Finally, they use Camtasia to create videos for their students. Sam also talked about their challenge with implementing scaffolding in an online environment:

And to me, the challenge is that building rapport with individual students. I find it a little easier in the physical classroom, but it is a little bit challenging for me building that rapport, getting to know a student more individually in the online environment. That, kind of, limits the types of customized scaffold that I can provide in the online environment.

Determining success of scaffolding practices

Sam talked about how they determine if a scaffold was successful through interactions with the students during the course, by looking at their assignments, including how often students refer to a scaffold, and by looking at course feedback. Sam further mentioned they value course feedback and take that feedback to improve the course for future iterations, "This year I get to integrate a lot of the feedback from [the] previous course with the same section I teach for this course...I value those feedback, and, integrate it, too. When I teach a course again, I take those feedback quite seriously."

Case summary

Sam's definition of scaffolding involved flexible and adaptable support based on students' needs. Another characteristic of their online scaffolding practice is fading; they remove scaffolding through students becoming more knowledgeable. Sam believes that "good teaching involves not only planning and selecting good materials, but also facilitating good classroom discussions and designing tasks that involve

Table 2 Examples of Participants' Hard and Soft Scaffolding and Corresponding Methods from the Literature

	Participant 1/Sam	Participant 2/Sarah	Participant 3/Elaina	Participant 4/Cora
Conceptual	Hard Video presented as complementary to reading materials (provide guidance on how concepts are related)	The instructor provided a template and worksheet for learners to guide an assignment on collecting, analyzing, and visualizing data (provide hints that direct learners to consider new, existing, or alternative resources)	Wiki Assignment that asks learners to consider definition of expertise in the field and review others' definitions to find relevant themes (relate new concepts to prior knowledge)	Online discussion focused on comparing and applying professional development models; (relate new concepts to prior knowledge / provide guidance on how concepts are related)
	Soft Audio feedback on assignments (provide guidance on how concepts are related / relate new concepts to prior knowledge)	Instructor provided an announcement to help learners relate statistical concepts like graphing, Y-intercept, and predictions to prior learned mathematics concepts (provide guidance on how concepts are related/ help learners relate new concepts to prior knowledge)	Instructor responds to discussion question responses as a whole and uses Socratic questioning to move it to next level (relate new concepts to prior knowledge)	Providing supplementary resources when students display a misunderstanding (helping learners relate new concepts to prior knowledge / provide hints that direct learners to consider new, existing, or alternative resources)
Metacognitive	Hard Voicethread activity that provides learners overview of how they should be planning for varying levels of student performance the levels in their classes; also use the levels to evaluate materials and eventually apply in classroom (promote self-monitoring or self-regulation / facilitate reflections on learning)	Students required to complete a self-reflection assignment about their learning in the class and draw a connection between their learning experiences and their own experiences in teaching (facilitate reflections on learning / promote self-monitoring or self-regulation)	A weekly lessons learned area (wiki or Padlet) since reflection is a very important part of case analysis process (promote self-monitoring or self-regulation/ facilitate reflection on learning)	Use of peer review rooms (groups) (promote self-monitoring or self-regulation)

Table 2 (continued)

	Participant 1/Sam	Participant 2/Sarah	Participant 3/Elaina	Participant 4/Cora
Procedural	Soft Discussion post response to student(s); asks students to reflect on their learning on a specific topic (facilitate reflections on learning)	Course announcement highlighting learning demonstrated in previous week (make understanding visible / facilitate reflections on learning)	Announcements that summarize learning on a particular case study (make understanding visible)	Prompting students to reflect on their learning within discussions, asking them to share "aha" moments (promote self-monitoring or self-regulation)
	Hard Video depicting step-by-step process on lesson analysis assignment (provide procedural direction on how to accomplish a task)	Provided a detailed assignment description with breakdown of steps through flip cards, along with a video of K12 learners in action (provide procedural direction on how to accomplish a task)	Video that introduces the structure, flow, and components of the course (provide orientation to learners on how to navigate the online course environment)	Discussion board guidelines with examples (provide direction on how to accomplish a task)
Strategic	Soft Weekly announcement(s) (provide guidelines including expectations for upcoming tasks)	Part of weekly announcements (text and video) incorporates reminders of upcoming tasks and deadlines (provide guidelines including expectations for upcoming tasks)	Announcement that provides reminder of how to accomplish a case analysis (provide direction on how to accomplish a task)	Written feedback that provides tips for being successful and allowing students to resubmit if below a C grade (provide direction on how to accomplish a task)
	Hard Use of videos to provide instruction and modeling for tasks (provides advice from experts)	The instructor provided probing questions for learners to think about before starting to work on their discussion post (use of probing questions as clues when learners start on a topic)	A walk-through module that shows students how to think through a case, to think about the case analysis process; Provide expert resolution to case analysis following course activities (provide advice from experts)	Provides overview, key points, and probing questions prior to readings; guides learners on approaches that support analysis (Use probing questions as clues when learners start on a topic)
Soft	Discussion post response to student(s) including Socratic questioning (use of probing questions as clues / suggest alternative methods or procedures)	Provides alternative resources and uses Socratic questioning within course discussions (suggest alternative methods or procedures)	Announcement that provides focus questions for the week's learning activities (probing questions as clues when learner starts on new case)	Worked example of how to read a research article with pop-up comments embedded in sample article (provide alternative explanation)

Table 2 (continued)

	Participant 1/ Sam	Participant 2/Sarah	Participant 3/Elaina	Participant 4/ Cora
Motivational	Hard	Note from former student on how to succeed in the class (promote expectancy for success / promote belongingness)	Instructor encouraged learners to work in groups and asked learners to identify their work style to achieve group goals (promote mastery goals)	In overview of course format (case analysis), explains that failure is a natural part of learning, in this case failure to fully understand the case analysis process without practice (promote emotion regulation / promote mastery goals)
	Soft	Audio feedback customized for each student based on their individual work (promote expectancy for success / promote mastery goals)	Feedback to students showing encouragement, care, and explaining how to improve work (promote expectancy for success / promote emotion regulation)	Announcement that includes pointers for course success and thoughts about the week's case analysis in terms of success and room for growing (promote expectancy for success)
				Provides multiple opportunities for extra credit as activities evolve in course (establishes task value)

getting students to make connections between what they learn and what they actually do in their life.” Aligning with their teaching philosophy, their interview and course observation data showed that their online scaffolding practice focuses on not only planning and selecting hard scaffolds, but also providing soft scaffolding to support students’ learning process during the course.

Sarah’s case description

Sarah has 6–10 years of experience in both K12 and higher education. Sarah had one year of online teaching experience. Sarah was first introduced to the concept of scaffolding in a doctoral level course on learning theories, as it relates to Vygotsky’s work.

Conceptualization of scaffolding

Sarah sees scaffolding as the “process by which learning efforts are supported.” However, when compared to the scaffolding definition we provided as part of this study, they wanted to clarify that, “I don’t see learning as a clear path,” with the given term or the language perhaps conveying a bit of uncertainty. Ensuring the individual learner path or context is also considered, as they noted “I think people take different paths in learning because you have different experiences, you make sense of what is being presented to you based on your experiences.”

Furthermore, Sarah talked about four parts or types of scaffolding based on their description: motivation (e.g., “something that will raise their spirits somehow”), conceptual (e.g., “what we learned from last week and how that contributes to what we are going to learn this week”), belongingness or community (e.g., “add something from a post that someone made”), and procedural (e.g., housekeeping information, deadlines). Specifically, Sarah explains they do not feel the definition provided by the research team is encompassing enough and stressed several times that community building is integral to make students feel comfortable and cared. Sarah clarified:

I do a lot of things related to relationships, like showing myself as vulnerable but also, like, sharing pictures, kind of trying to get them to feel excited about something, or it might be by trying to connect them. Like, as I said before, like, “Oh, did you see what she wrote? I’m so glad you learned this from this person.” Trying to make them feel like they are learning also from each other.

When asked about the hard and soft scaffolding, Sarah described the role of hard scaffolds, “Going into that course design process for an online course hopefully you know the big challenges that students might have based on our previous experiences teaching the course in other environments.” On the other hand, they explained soft scaffolds as:

I see it as the things that you do while you are teaching the course, during course implementation. Let’s say I’ve been part of building a course and then teaching it...you are trying to, in the moment, to address those things.

Instructor's process for designing and developing scaffolding

When designing courses, Sarah discussed course scaffolds as contextual and personal to learners:

I think I've been learning about how to teach stuff by teaching and reflecting on what I do, so whatever I know now about the scaffolding, how to provide guidelines so that my students get something out of the course, is based on reflecting on my experiences on how I see that things are productive in terms of the feedback that I get from students or how I feel about doing it...I will pay attention to whatever the students said in the course evaluations.

Implementation and evaluation of scaffolding

From the data sources, it appears as if Sarah uses learner feedback as a major input for conceptual and metacognitive scaffolding. When multiple learners are struggling to understand a concept, they provide alternative resources through course announcements. Additionally, meeting with each student is important, noting the need for "10 min meetings where I say who I am and what I expect from them. Then I share with them my phone number so they can email me or text me or we can FaceTime or whatever works for them. So I try to show myself as available."

We found evidence of both hard and soft scaffolding practices within Sarah's course for all five types of scaffolding strategies we were investigating; see Table 2. In addition to the scaffolding strategies covered in the study, Sarah spoke several times about the idea of community and belonging, as a scaffolding strategy:

The belonging is a big piece of my way of teaching. I think they need to feel that they are part of a group, and I promote, like, as I said before, I try to make comments so that they see the value of being with others.

One challenge for Sarah with their scaffolding practices was the newness experience combined with thoughts of misinterpreting students' writings in terms of cues and level of understanding.

The other thing that is challenging in online courses, like when I'm doing the in-time feedback or in-time scaffolding, you know, I read what they write, and I have a sense of how they're understanding things, but I might be wrong because it's also through my lenses. So I have biases, and then I don't know those, because if I would know them then I would be perfect, and I'm not. So that is kind of challenging, right?

Sarah discussed several tools useful for their scaffolding approaches. In particular, they talked about the use of videos created for conceptual issue clarification. Tool availability, especially the tools useful for their scaffolding strategies, is another challenge Sarah mentioned several times during their interview: a tool (Padlet) was discontinued, a change of learning management system (Blackboard

to Brightspace), and another tool's (VoiceThread) license was not renewed by the University.

Determining Success of Scaffolding Practices

Sarah spends time getting to know their students and checks-in with each student regularly. Noted they do the "mom thing," Sarah meets with a particular student at a designated time each week because that was what worked best for the learner. As this past year was the first for Sarah to teach online, they acknowledged they were still trying to find a rhythm for teaching:

When I look at the students' evaluation... So I kind of am getting good feedback, so that is how I know it's going well. I also, whenever I read their posts and they say things like, "Oh, I didn't know about this," or, "I'm excited about this," or, "I had an eye-opening," all of those things to me are, like, small celebrations that something is working. So that is how I know.

Case summary

Sarah's definition of scaffolding focused on supporting students by considering their previous experiences and building community. According to Sarah:

...learners' learning journeys are different because they are all different people. I see my role as being the one who emotionally and academically supports them so that they feel they are making progress wherever they are. Successful instructors are those who have an active online presence.

Aligning with their teaching philosophy, the interview and course observations data showed that Sarah's online scaffolding practices focus on supporting students' individualized learning process as well as building a sense of belonging and community in their online courses, which she views as unique to the online environment.

Elaina's case description

Elaina has extensive teaching experience in higher education and K-12. Elaina is an early career person, but has more than ten years of experience teaching online courses. Elaina was first introduced to the term scaffolding early in graduate school discussions about learning theories and the zone of proximal development, but did not fully appreciate or understand scaffolding until it applied to their own work and they examined it more deeply.

Conceptualization of scaffolding

Elaina sees scaffolding as intentional support(s) provided by the instructor, "It's support that makes the learning experience more attainable, and in some cases, it might not otherwise be possible without the use of this type of support...you've

intentionally integrated it into a learning process. So you're more active with that integration." They follow up by explaining that the difference between a scaffold and a general resource is that:

Scaffolding is meant to be temporary, and it's being applied in the course to achieve a specific learning outcome in the immediate future, something that the instructor has intentionally designed for a specific purpose. General resources are something that learners can take beyond the learning experience and use at their own discretion, not necessarily in ways that the instructor has a specific use for.

They further clarified that scaffolding should be guided and faded over time unlike general resources, "If we think of scaffolding as a construction tool that's there to help the building process, it's supposed to be removed once you get your construction complete, right?" Elaina views hard and soft scaffolds as equally integral. They think of hard scaffolds as "things that I know ahead of time that students are going to have challenges with" and use them to provide guidance upfront. Whereas soft scaffolds are:

...ones that can be implemented as needed... You have to be flexible enough to be able to do this in a way that you're still putting it back on the student, it's kind of like...I don't know if you've heard of the term "reflective toss." But again, it's like this give and take, where you're acknowledging what's being said, but you're at the same time, working to help students shoulder that sense-making process.

Instructor's process for designing and developing scaffolding

According to Elaina, scaffolds can "look very differently from one course to the next, depending on the variation of learning outcomes and the timing of a course in a program." Elaina talked about the thought process they go through when they design an online course for the first time, and how it is more a matter of guesswork about "where students are going to have challenges. But you're not totally sure where that is until you teach students and you think, 'Oh, that's something that they struggled with, and I didn't anticipate it.'" When planning hard scaffolds, they consider what could potentially be covered, main topics, expected student outcomes, related topics, and what might be challenging for some students.

They also talked about the challenges in designing a course that they may not teach, but will oversee all the sections of the course:

I feel like there's extra pressure to build in these types of preplanned scaffolds, because you don't know [if] other people are going to be able to facilitate the course the way that you envisioned, or what their experience is with doing just-in-time scaffolding. So I think that really can be a challenge.

They talk about their advanced graduate level course and knowing for the most part where students are going to have challenges. Over time they have tried different

hard scaffolds, saying “Even after we tried different ones, hoping that maybe this was the magic bullet, there’s still challenges.” Given this, they feel that regardless of the course and the preplanning that “just-in-time, or the soft scaffolds are just as important, because you have to be able to read, you have to be flexible, you have to be able to jump in.” A unique aspect they shared was about the importance of student buy-in on a scaffold:

This is an example of something that I’ve adjusted. So I shared the “lessons learned” Padlet that I ask students to complete at the end of each case [case-based learning]. And when I first created the Padlet, I had both... I had a lot of students that pushed back and said, “We don’t see the purpose of this. This is just an add-on assignment.” So I realize that I knew it was very valuable, because I understand how students learn and work through the process. But I understood that I did not communicate that well to the students.

Related to the just-in-time or soft scaffolds and knowing that they cannot always be planned ahead for those, Elaina explained they go into the course knowing the discussions will be an area where challenges arise, having certain questions they plan to use in the discussion to help guide students as needed. Ultimately, they hope that “they [scaffolds] are helping the students develop their thinking in these complex situations, again, without telling them the answers.”

Implementation and evaluation of scaffolding

During the interview, Elaina shared several go-to scaffolds included in all of their courses:

I always create an introductory video that I try to walk them through course expectations, and then acclimating them with what’s going to be expected. So that’s one thing. And then, I always do a check-in video at least halfway through. And then, discussions. I think there’s always... I have a certain style, and that’s always asking questions in the discussion and prompting learners to think through, or for me to share experiences or resources that connect them. So I would say that those are ones that I always use.

Aligning with the interview data, we found evidence of both hard and soft scaffolding practices within Elaina’s course for all five types of scaffolding strategies we investigated: see Table 2). In Elaina’s situation, many of the scaffolds used can be categorized into more than one scaffolding type. For example, in a case-based learning course, a walk-through module that shows students how to think about case analyses provides metacognitive scaffolds (students think about the cases analysis process), conceptual scaffolds (providing guidance on how concepts are related, activating prior knowledge), procedural scaffolds (accomplishing tasks), and strategic scaffolds (strategies for general problem-solving processes).

The importance of metacognitive scaffolding strategies was discussed on several occasions in Elaina’s interview. Reflection is a large part of Elaina’s course as it is an advanced graduate level course, one that helps move learners from novice to expert

through the use of case-based learning. Additionally, Elaina provides assignments which use metacognitive scaffolding strategies as well. One, is a reflection at the end of the course focusing on developing expertise where students go back and examine their own practices. As they explain, "This [provides] a chance for self-examining... so that they could see where their own strengths and weaknesses were. So it's not just, "Oh, it's coming from the instructor," but they are self-reflecting there."

Additionally due to the advanced nature of the course, Elaina uses motivational scaffolds because the course can initially be challenging for all learners. These motivational scaffolds are in the form of emails sent a couple of times in each course, where the instructor reaches out to students individually. For example,

Especially if I see students that are struggling and are really frustrated, I'll email and say "Hey, it's okay. This takes time." And I try to wrap up the case, too, with some final thoughts, like, "Hey, this is a safe place, so it's okay that... if you don't get it right now."

Specific to scaffolding, Elaina discussed how important discussions and videos from experts were used as scaffolding tools. With discussions, especially for conceptual learning, students can "see" their learning and make sure they are on the right path. If not, instructors can add resources as needed to guide the learners. For strategic scaffolding, they discussed the use of videos where experts walk through a particular case and share with students their thinking process. Elaina also discussed creating short procedural scaffolding videos using Camtasia or Screencast software.

Determining success of scaffolding practices

In the advanced course, Elaina explains, the scaffolds are really about helping learners think about their learning process and problem solving. For Elaina, what students think about the specific scaffolding is another consideration for success of scaffolds. For instance, the walk-through module that shows students how to think through a case was gauged as successful because "students talk about that being useful and how they've gone back to it and watched it multiple times, or completed it multiple times to think through [the process]."

More generally, they determine a scaffold is successful when they see changes in the learner's progress.

For instance, if we look at student work progressing over the semester and you see that improving, I think that's one sign. I think that when students feel more supported, they're more positive about the learning. So I think that that's one way you can check attitudes...but it's not, again, perfect. I'm looking for improvements. If things are staying the same, even with the scaffold, then I would say, "We need to try something else," because this clearly is still not getting us to where we want to be.

Case summary

Elaina's definition of scaffolding included intentional support to guide students in the learning process to attain learning outcomes. According to Elaina, a successful instructor is compassionate, flexible, positive, and patient. Aligning with their teaching philosophy, the interview and course observations showed that Elaina's online scaffolding practices focus on supporting students intentionally through various channels. Unique to the online environment is the need for walk-through modules, as with their module for how to think through a case analysis.

Cora's case description

Cora has an extensive teaching background in K-12 and higher education. They are an early career person and have been teaching online for three to five years. Because they have been an educator in some form or other for about 30 years, it is hard for them to recall when they first heard about scaffolding, probably during their undergraduate teaching program.

Conceptualization of scaffolding

As an instructor and a course designer, Cora explains they need to be knowledgeable about their content but also their learners in order to provide scaffolding, "And then, match the scaffolding strategy that I use to their needs, their learning needs, and also, I would say to some degree, their social-emotional needs." When defining scaffolding, they talk about differentiation and that scaffolding should provide support(s) to make "high quality and advanced content reachable by all students." They go on to discuss scaffolding as natural and being integral to their teaching persona to help their students learn.

Cora distinguishes scaffolding from general resources by explaining scaffolding as intentional, and they choose scaffolds because a learner needs it, whereas general resources are part of their toolbox: "So, a scaffold is, in my mind, something that is a response to a learner, and that response comes from what I know about my content and what I know about my learners."

When discussing hard scaffolds, Cora explains that they are created during the design phase of the course and after summative assessment to provide enough content for students to achieve learning outcomes:

Hard scaffolds are generally determined during that instructional design phase, the lesson planning process, again, with the content and my students' learning needs in mind and their characteristics in mind. I think about the interaction between my students and the content. And so as I think about that, I think about, as I said earlier, any kind of social-emotional concern that I think might arise based on a topic we're discussing, but definitely the academic side as well. I also have planned hard scaffolds, scaffolds after summative assessment when students did not perform as I had anticipated or expected or wanted. And

so re-teaching parts of the content using different scaffolds, pre-planned scaffolds is in order and so I've done that.

For Cora, soft scaffolds are determined when delivering instruction. For example, "frequent formative assessments" such as exit slips are used to help plan their soft scaffolds for the next session, "something that's a little more responsive rather than anticipatory." Similarly, they also utilize student discussion board responses and assignments to "figure out, 'Oh, I see, you know, they're missing this piece.' So, I'm going to go back and just, you know, chat with them through the discussion board or email them, have an email exchange about a certain concept."

Instructor's process for designing and developing scaffolding

During course planning, it is important to note that Cora's courses generally have three audiences intermixed: undergraduate students, graduate students, and practicing teachers. Therefore, their planning process involves examples of the variations they included in their courses for each audience. Regardless of the audience, they approach teaching and designing the course from a position of "challenge":

So, I'm choosing high-quality content. I'm choosing content that I believe will be challenging for probably the more advanced students in my courses, but then the scaffolding that I provide are the supports needed for those who may come into the course not knowing as much as others...so, there's closer monitoring involved for these students that I believe will have a bit more challenge reaching my learning goals than others. And in scaffolding, I would provide many, many kinds of supports to them, more structured kinds of learning questions, explaining content in simpler terms, providing the key points beforehand...so, kind of front-loading learning experiences so that I'm sure they're looking for the important things that I want them to notice and to learn.

They also talk about the need to provide students with support regarding study skills, "If students don't know how to take notes, they don't know how to get the most out of a reading...So, study skills I feel like is an important part of scaffolding for many learners." As a metacognitive scaffold, skill support can be seen as a way to help learners reflect on their learning processes.

Implementation and evaluation of scaffolding

During the interview, Cora talked about key pieces included in all of their course designs, such as sharing rubrics for discussions and assignments (procedural and metacognitive), requiring student introductions (motivational), providing worked examples and exemplars for assignments (both hard and soft as needed), and written feedback (motivational, conceptual, strategic, metacognitive, and procedural). Interestingly, Cora identified two aspects essential to their teaching philosophy and instructional practices that do not easily fit within our model: (1) addressing socio-emotional needs of students, which can be motivational but also goes beyond to include a space where they can feel comfortable disagreeing with others

(respectfully); and (2) the idea of differentiation for varying audiences, which can include motivational strategies associated with establishing task value. Additionally, they talk about foundational skills, including study and writing skills that go beyond the scope of their own course content. For these skills they suggest resources, providing detailed written feedback, and utilizing external sources such as the writing lab. When we observed Cora's online course, we found evidence of both hard and soft scaffolding practices and all five types of scaffolding strategies this study investigated; see Table 2.

While implementing scaffolding in their online courses, one challenge Cora talks about in detail was learning to communicate effectively with their students, as the online environment differs from face-to-face which they have been working in for so long,

I guess the biggest challenge for me is figuring out the best ways to communicate with the students online because I can't be with them face to face all the time. I can create experiences where we are together, but most of our communication, especially from me to them and delivering content, is going to be through Blackboard, through written communication. And so I think that the biggest challenge is trying to make that impersonal platform of Blackboard more personal. And I have incorporated videos lately of myself ... so, at least they can hear my voice instead of maybe reading three chapters in the book. I think my difficulties are around communication, my teacher voice, an invitational style, and one that is just not sterile.

This above challenge goes beyond communication alone, as Cora discussed wanting to scaffold to students' socio-emotional needs, making their course welcoming, making their persona come through as caring, and overall connecting with their students as a guide or facilitator through the learning process.

Determining success of scaffolding practices

Cora talked about reflecting after each course offering, what went well and what did not so they can plan better for the next course and "trying to approach my content through different means especially when one seems to be ineffective." Sometimes this involves student success with an assignment that incorporates scaffolds, sometimes with more summative evaluation such as "exit slips." They discussed how students' assignments were used to gauge individual learning throughout the course and how Cora's written feedback was one way they helped individualize the scaffolds to fit the needs of each student. In one situation, they explained how having the undergraduates engage with very research-heavy articles is sometimes difficult as the learners struggle to grasp the key ideas. Therefore, Cora developed hard scaffolds to help this audience (e.g., undergraduates) reach the learning level they need to be successful in the course.

Case summary

Cora's definition of scaffolding included supporting student learning and socio-emotional needs. According to Cora, successful instructors "provide high-quality content and respectful tasks that challenge all students while providing appropriate supports to students who struggle." Aligning with their teaching philosophy, the interview and course observation data showed us Cora's scaffolding practices focus on (a) providing high quality and advanced content reachable by all students; (b) supporting students learning process and socio-emotional needs; and (c) differentiation of their practices for various audiences. They indicate that communication and related scaffolds are of special importance in online learning environments.

Discussion

This multiple case study aimed to explore how instructors conceptualize and practice scaffolding in their online courses in a higher education setting. This section provides a cross-case analysis of the four cases to build explanations and justifications of the study's findings in relation to prior research.

Instructors' conceptualizations of scaffolding

All participants defined scaffolding as intentional support(s) for students in their learning process, aligning with both Wood et al.'s (1976) and Pea's (2004) definition, albeit with personalized features. The cross-case analysis showed that scaffolding in online learning is a response to learners' needs. All four participants held with the traditional conceptualization when explaining the purpose of scaffolding. Elaina further noted that both intentional and temporary support to help students achieve learning outcomes is necessary to support students' achievement of course goals. Sam explicitly acknowledged the essential characteristic of autonomy when explaining that scaffolding entails supporting students "to be able to do what they cannot do by themselves." Their perspective agrees with Reiser and Tabak's (2014) skill-based approach that focuses on closing the gap between the learners' current skills and the targeted skills (Reiser & Tabak, 2014).

As for the conceptualization of scaffolding, Sarah's and Cora's conceptualizations went beyond our initial framework. In Sarah's situation, scaffolding was divided into motivation, conceptual understanding, belongingness or sense of belonging. In particular, Sarah stressed that due to the nature of online courses, supporting students' sense of belonging in online courses is one of the biggest aspects of their scaffolding practices. For instance, when instructors showed themselves "as vulnerable" to connect with students who were going through difficult situations, or when Sarah connected with a student based on their shared fondness for the Smoky Mountains. Socio-emotional scaffolds that focused on community building looked to connect learners by signaling to peers' work like "Oh, did you see what she wrote?" Unlike motivational scaffolds which focused on attaining learning goals (Belland

et al., 2013), we found socio-emotional scaffolds to be different because instructors shared aspects of their personal lives when establishing emotional connections with learners.

In the case of Sarah, the conceptualization of motivation and conceptual understanding scaffolding overlap with Belland et al. (2013) and Hannafin et al. (1999), respectively.

Cora, our Gifted and Talented Education faculty, focused on learners' social-emotional needs and proposed that observation is essential to tailor scaffolding for each learner. Likewise, Sarah also mentioned that learning is not a clear and sequential path; thus, individual learning paths and experiences should be considered when providing scaffolding. Aligning with Reiser and Tabak's (2014) concept of differentiated scaffolding, both Sarah and Cora advocated for individual oriented scaffolding rather than a group perspective to support student's individual needs. In Cora's case, the focus on differentiated instruction would be related to their discipline. As educators, they model the use differentiation strategies in their own teaching, expecting teacher-learners to replicate differentiated scaffolding with their learners. Likewise, Sam, our English Language Learning faculty, described scaffolding as being visual and linguistic. Similarly, Sam highlights scaffolding functions that could be specific to the context of language learning like group configurations and language support. Consequently, the results showed that even though all participants provided a common definition of scaffolding, their conceptualization of scaffolding differed based on their disciplinary practices.

Instructors' process for designing and developing scaffolding

The process participants described when designing and developing a scaffold provided mixed results. First, all four participants in our study expressed how intentional planning of hard, or preplanned, scaffolds were considered when designing their online courses. For instance, according to Sam, "Hard scaffolds come into play during the designing stage of the course." Additionally, Cora noted the importance of understanding where learners struggle based on summative assessment results when developing the scaffolds.

Furthermore, taking into consideration their students' needs, all four participants discussed using soft, or just-in-time, scaffolds. This finding is not surprising as soft scaffolds are used by instructors to 'reduce task complexity' most commonly "through modeling or making thinking visible" (Ertmer & Glazewski, 2019, p. 236). For Cora, soft scaffolds are "responsive rather than anticipatory" showing their insights are supported by prior conceptualizations of soft and hard scaffolds (Brush & Saye, 2002; Shin et al., 2017). Using the course discussions and conversations as means to scaffold students is a popular technique among experienced instructors (Ertmer & Glazewski, 2019) as the practice "help[s] their students develop better understandings of concepts and content" (Akerson, 2005, p. 248). All four participants also discussed how soft scaffolding really varies based on the learner population of the course and suggested being flexible and differentiating the types of scaffold based on student needs.

As a verb, scaffolding is a *process* that occurs over time and until learners achieve autonomous performance (Pea, 2004). In theory, scaffolding is only provided when assistance is necessary and eventually, “all scaffolds are gradually removed depending on the learners’ level of development” (Doo et al., 2020, p. 63). While the practice of fading has been noted as “a necessary component of scaffolding” (Belland et al., 2017, p. 330), many studies conducted on the topic disregarded the use of fading or did not include fading in their research (Belland et al., 2017; Chernikova et al., 2019). Of those studies that do (e.g., Belland, 2011, 2014; Pea, 2004), research has shown that fading “has been promoted as a method to promote transfer of responsibility for the scaffolded task” (Belland, 2014, p. 508). In our findings, only two instructors (Elaina and Sam) discussed intentionally fading their scaffolding as learners become more knowledgeable or proficient on a topic. Elaina specifically noted this in their interview by stating, “I think that sometimes with scaffolds, we forget the temporary part...that it’s supposed to be faded over time. So that’s something to keep in mind.” Similarly, Sam clarified that opportune scaffolding removal occurs when learners build a sufficient understanding of the subject matter or achieve mastery of the skill.

Among the four participants, Cora was the only one who highlighted differentiated hard scaffolds for various learners (i.e., undergraduates, graduates, and practicing teachers) in their graduate-level courses. Differentiated scaffolding has previously been used to support ambitious learning practices (Glazewski & Hmelo-Silver, 2019). For example, Cora adjusted the level and type of readings for their students to better align with their abilities. Specifically, they provided more research-based articles for graduates and practicing teachers, and more practitioner-oriented materials for undergraduates.

Implementation of scaffolding practices

The use of both hard and soft scaffolds for all five types of scaffolding (conceptual, metacognitive, procedural, strategic, and motivational) were found across all four cases. It is important to note that all four participants were trained educators with extensive teaching experience, and three of them had rich online teaching experience, which may be related to this finding. Looking across all four cases, due to the nature of online courses, instructors used various channels in the form of soft and hard scaffolds to support students’ learning processes. For instance, Sam uses an “ask the instructor” discussion forum to answer student questions, creates a space for peer interaction to share their understanding of the course material, and sends bi-weekly announcements to provide students with feedback and highlights. In Sarah’s situation, they use course announcements to provide alternative resources when multiple students struggle with the course content and meet students via video or phone call to create sense of belonging. In Elania’s case, they create introductory video walk-throughs to communicate about course expectations and actively participate in discussion forums to prompt students to think through the course content.

As for the soft scaffolds, we observed that each participant applied all scaffolding types; however, the implementation of those scaffolds varied. For instance, Elaina

and Cora were active in course discussions to prompt and guide students and gave direction to conversations. Sarah and Sam preferred to use individual student feedback or course announcements for much of their soft scaffolding. Hard scaffolds were sometimes parallel to those used in traditional classrooms (e.g., self-reflection (metacognitive); detailed assignment descriptions with probing questions (procedural and metacognitive)), while others were unique to the online environment including a case walk-through to understand how case-based learning is applied (strategic), course overview videos (procedural, motivation), and peer review groups or rooms (metacognitive). These variations in implementing scaffolds often depended on the specific student groups that individual instructors dealt with and concurred with Shin et al. (2017) that scaffolding may take multiple forms depending on the varied instruction delivered to students. Using a variety of scaffolds for different situations is also aligned with Sawyer's (2011) claim that both soft and hard scaffolds should be used in a way that does not overwhelm and under-challenge students. Furthermore, this finding is in line with the differentiation made by Hannafin et al. (1999) and Belland et al. (2013) between scaffolding types and mechanisms. While all four participants utilized all types of scaffolding (i.e., conceptual, metacognitive, procedural, strategic, and motivational), their mechanisms for implementing these scaffolding types were different considering task intention.

Participants utilized specific technology tools depending on their contexts and preferences. For example, we observed videos (conceptual, procedural, and strategic scaffolds), audio feedback (conceptual and motivational), VoiceThread activities (metacognitive), wikis (conceptual), and Padlet (metacognitive) as hard scaffolds; discussion board posting responses (conceptual, metacognitive, and strategic), videos (conceptual, procedural, and motivation) and announcements (procedural) as soft scaffolds. The similarity of the technology tools among the four cases might result in part from the tools commonly provided by most learning platforms (e.g., online discussions) but other tools were sought out by the instructors (e.g., Padlet and Voice Thread) and not widely used at the participants' University.

Moreover, participants talked about the challenges they faced in implementing scaffolding in their online teaching. First, identifying an individual's needs for different scaffolds (Sam), especially the emotional needs (Cora), is more difficult online in comparison to face-to-face contexts. More specifically, it is difficult to provide just-in-time scaffolding to different learners while making personal connections to provide the learners social-emotional support. In a meta-analysis conducted by Doo et al. (2020), they found a few articles (e.g., Huang & Huang, 2015; Roll et al., 2018; Yilmaz & Yilmaz, 2019) focusing on the use of scaffolds in the affective domain. These articles examined learning satisfaction and learning engagement which could be related to our finding in focusing scaffolds on providing social-emotional support, especially since Doo et al. (2020) called for, "more scaffolding opportunities should be provided to students within affective learning domains" (p. 72). However, providing emotional and social-emotional support is challenging as "students experience a wide array of emotions in academic settings, which profoundly affect their thoughts, motivation, and actions" (Back et al., 2020, p. 389). Due to the variation of each learners' emotional support needed, the challenge becomes identifying and providing the right amount of scaffolding, a challenge supported by Dabbagh (2003)

who notes, “that some learners may require little or no structure and others may require a lot of structure” (p. 40).

In general, scaffolding success has been associated with actions where “collaboration or assistance for a learner or group of learners from teachers or other more able partners who must provide appropriately challenging activities accompanied by the right quantity and quality of assistance” (Luckin, 2008, p. 450). However, the measurement of successful scaffolds is an area missing from the current literature. In terms of determining the success of scaffolds, all participants looked to evidence gained from their students’ experiences, such as interaction with the students during the course, assignments, changes through the learning process, summative and formative evaluation (learning outcomes, course evaluations). Together these inputs guided instructors in their course improvements and the need for scaffolds for future iterations.

Study implications and future research

Practical results from our study provide insights and examples of specific scaffolding strategies from instructors’ online courses that can serve as models for other instructors, both novice and expert. Research implications include the potential extension of motivational scaffolds to include socio-emotional supports, as several of our participants felt this was an essential component of their teaching philosophy. Similarly, due to the nature of online environments, at least one instructor discussed the need for scaffolding students’ community-building efforts. Additionally, several of our participants discussed the need for fading of scaffolds, but the timing and choice of how to fade scaffolds remains unclear (Tawfik et al., 2018), especially with the ubiquitous and asynchronous characteristics of online learning that impose storage of scaffolds (e.g., emails, replies in discussion boards). Finally, the results showed that instructors’ conceptualization and implementation of scaffolding may be discipline-specific and future research might focus on the disciplinary differences in the scaffolding practices.

We also wish to acknowledge several limitations of this study. First, while not purposeful, all participants are experienced educators and trained as K12 teachers. Second, all participants that responded to the request for participation were from within a single College of Education. Third, all courses were designed or co-designed by the participants. Finally, all cases were based on graduate-level courses. Future research should examine how our findings hold with cases from other disciplines, levels of coursework, and non-designer instructors and further explore concepts touched upon here by our participants (e.g., fading, differentiation, conceptualizations more generally). Finally, case study research is typically not meant to be generalizable to other contexts and situations, thus we provided rich descriptions about the research contexts and participant’s conceptualization and implementation of scaffolding in their online courses to help researchers and practitioners implement the research findings in their own context.

Conclusion

In conclusion, this multiple case study provided a deep understanding of how instructors conceptualize and employ scaffolding in online courses. The results showed that instructors defined scaffolding as a support to help students achieve course outcomes. However, participants' conceptualization of scaffolding differed based on their discipline and their teaching philosophy. Additionally, we observed all five types of scaffolding in hard and soft scaffolding forms in all four cases. However, how they employ scaffolding was different. The results of this study provide insights and perspectives into conceptualization and applications of scaffolding in online courses from instructors' point of view. Instructors can use such insights when designing and implementing scaffolding in their online courses. In addition, the results showed that instructors' conceptualization and implementation of scaffolding could be related to their disciplines. Thus, instructional designers can use the results of this study to communicate with instructors regarding scaffolding practices. This study achieved analytical generalization (Yin, 2014) by corroborating and advancing the conceptualization of scaffolding, specifically, in online learning. Finally, the Scaffolding Glossary ("[Appendix A](#)") created as part of this study and the examples from the participants (Table 2) can serve as a go-to resource for instructors looking for ideas or models of different types of scaffolding and their associated strategies when designing and implementing scaffolding in their online courses.

Consent to Participate

Informed consent was obtained from all participants included in the study.

Ethics Approval

Human subject concerns were addressed through approval from the Institutional Review Board (IRB) of the university.

Conflicts of Interest/ Competing Interest

The authors have no relevant financial and non-financial interests to disclose.

Appendix A

Research Team's Scaffolding Glossary

Terms (and sample codes)	Definition	Example
Scaffolding (Code DEF_SCAFFCON: Conceptualization of scaffolding (can be process or tool))	It is the process through which learning efforts are supported. Scaffolding happens when a “more knowledgeable other”, or tutor, helps a learner to perform certain tasks until the learner can do it independently (Glazewski & Hmelo-Silver, 2019; Reiser & Tabak, 2014; Wood et al., 1976). Scaffolding and guidance are considered the same (Glazewski & Hmelo-Silver, 2019)	
Pre-planned (hard) scaffolds (Code DEF_PRE: Pre-planned scaffold definition/description)	Typically fixed and technology-mediated scaffolds which can be planned in advance in terms of potential difficulties of a learning task (Brush & Saye, 2002; Sharma & Hannafin, 2007)	<p>Example 1) An instructor evaluates the instructional content and feels learners may be unfamiliar with some concepts, then the instructor provides necessary background information or resources for learners to view before the learning task</p> <p>Example 2) An instructor predicts the problems/challenges that learners may face during the learning activity beforehand and provide guidelines/prompts to overcome those challenges</p>
Just-in-time (soft) scaffolds (Code DEF_JIT: Just-in-time scaffold definition/description)	Typically customized, situation-specific, and timely aids provided by a more knowledgeable person like an instructor to help with a learning task or a learning process (Brush & Saye, 2002)	<p>Example 1) When a learner does not know how to use a tool for analysis and the instructor provides a video tutorial</p> <p>Example 2) When an instructor notices that a learner/group of learners is misunderstanding concepts in online discussions and provides a clarifying post/resource defining the concepts</p> <p>Example 3) an instructor provides differentiated feedback to learners which allows negotiation between the learners and scaffolds (Kim & Hannafin, 2011)</p>

Terms (and sample codes)	Definition	Example
General resource	A general resource is information given without guidance or direction	Posting "optional resources" that learners can explore on their own, but aren't directly part of the course content, instruction, or assessment For example, when the instructor shares a newspaper article related to a current issue in the field of instruction

Scaffolding Types

Scaffolding types	Scaffolding Functions (and sample codes)	Scaffold Methods	Examples*
Conceptual	<i>Guides learners in what to consider when the problem under study is defined. In other words making key concepts and their interrelationships related to a problem or learning task apparent to learners</i> (Code ST_CON: Conceptual scaffolding type & method)	<ul style="list-style-type: none"> • Providing hints that direct learners to consider new, existing, or alternative resources (Hannafin et al., 1999; van de Pol et al., 2010) • Providing guidance on how concepts are related (Hannafin et al., 1999) • Help learners relate new concepts to prior knowledge (Stavredes, 2011) 	<ul style="list-style-type: none"> • Suggesting a learner use a tool to clarify understanding (Hannafin et al., 1999). Suggesting software to support understanding • Glossaries, list of definitions (Stavredes, 2011) • Templates that learners can fill out during the problem solving process (Kim & Lim, 2019) • Advance organizers, graphic organizers, infographics, structure maps to link new content to prior knowledge (Hannafin et al., 1999; Stavredes, 2011) • Instruction/explanation (van de Pol et al., 2010) • Study questions before an exam to help learners focus on important information (Stavredes, 2011)
Metacognitive	<i>Guides learners on how to think about learning and during learning (e.g., ways to think about a problem under study)</i> (Code ST_META: Metacognitive scaffolding type & method)	<ul style="list-style-type: none"> • Promote self-monitoring or self-regulation (Hannafin et al., 1991) 	<ul style="list-style-type: none"> • Study plans, schedules • Task checklists • Suggest learners plan ahead and evaluate progress—e.g., proposing self-regulating milestones and related monitoring (Hannafin et al., 1999) • Provide templates, worksheets, or worked examples to prompt learners to monitor their understanding (Stavredes, 2011) • Help learners monitor (self-regulate) their comprehension of major concepts and ideas through practice tests (Stavredes, 2011)

Scaffolding Types

Scaffolding types	Scaffolding Functions (and sample codes)	Scaffold Methods	Examples*
		<ul style="list-style-type: none"> • Facilitate reflections on learning (Kim & Lim, 2019) • Make understanding visible 	<ul style="list-style-type: none"> • Reflections after activities • Asking students to reflect on how they planned, organized, and monitored their learning (Stavredes, 2011) • Suggesting learners plan ahead • Suggesting learners evaluate progress and determine needs (Hannafin et al., 1999, p. 131) • Provide opportunities for learners to externalize their misunderstandings (Sharma & Hannafin, 2007)
Procedural	<p><i>Guides learners in operational aspects of the learning environment (e.g., how to utilize available learning environment features; tools)</i> (Def: Kim & Hannafin, 2011) (Code ST_PROC: Procedural scaffolding type & method)</p>	<ul style="list-style-type: none"> • Provide guidelines for discussion boards such as timeline, expectations of number of posts and deadlines (Land, Choi & Ge, 2007) • Provide procedural direction on how to accomplish a task (Dabbagh, 2003) • Provide orientation to learners on how to navigate the online course environment (Stavredes, 2011) 	<ul style="list-style-type: none"> • A screencast created by the instructor to explain the requirements of participating in discussions • Discussion participation rubric • Provide learners with tips and cues (Dabbagh, 2003) • Video of online class layout • Create a course orientation by explaining the course layout and highlighting features (e.g., syllabus location, assignment box, library links, technical support) (Stavredes, 2011; Tomei et al., 2009)
Strategic	<p><i>Guides learners on approaches that support analysis, planning, strategy, and tactical decisions during learning or problem solving process</i> (Code ST_STRAT: Strategic scaffolding type & method)</p>	<ul style="list-style-type: none"> • Provide advice from experts (e.g., modeling the type of responses expected in discussion boards) (Belland, 2014) • Use probing questions as clues when learners start on a topic (Hannafin et al., 1999) • Suggest alternative methods or procedures (Hannafin et al., 1999) 	<ul style="list-style-type: none"> • Modeling by experts (e.g., “this is how I would approach the problem”) (Belland, 2014) • Giving hints that deliberately obscure the whole solution, but give clues about a way forward (van de Pol et al., 2010) • Providing alternative explanations or approaches to the problem at hand including worked examples or supplementary resources (Hannafin et al., 1999; Stavredes, 2011)

Scaffolding Types

Scaffolding types	Scaffolding Functions (and sample codes)	Scaffold Methods	Examples*
Motivation	<p><i>Guides learners' to deploy effort toward and persist in the learning task (e.g., address learners' abilities to successfully complete task and perceive value in task completion</i> (Belland et al., 2013)</p> <p>(Code ST_MOTIV: Motivational scaffolding type & method)</p>	<ul style="list-style-type: none"> • Establish task value (Belland et al., 2013) • Promote mastery goals (Belland et al., 2013) • Promote belongings (Belland et al., 2013) 	<ul style="list-style-type: none"> • Prompt learners to select an aspect of the problem that they are interested in exploring and investigating (Palmer, 2009) • Help students see the connection between their current assignments and future benefits or advantages of completing the tasks to foster perceived value of the task • Guide and encourage learners to create short-term goals to achieve • Focus feedback on essential/core parts or sections which are easily to be misunderstood of student work • Encourage learners working in groups and ask learners to reflect on how working in groups help them achieve individual and group goals • Encourage students to create shared goals that align with the main problem • Demonstrate the potential connection between individual goals and group objectives to encourage shared goals • Accommodating social goals by describing how consciousness of the shared goal can support learners achieve social responsibility goals • Allow learners to co-construct criteria for judgement of quality

Scaffolding Types

Scaffolding types	Scaffolding Functions (and sample codes)	Scaffold Methods	Examples*
		<ul style="list-style-type: none"> Promote emotion regulation (Belland et al., 2013) Promote expectancy for success (Belland et al., 2013) Promote autonomy (Belland et al., 2013) 	<ul style="list-style-type: none"> Explain that failures are the natural part of learning and engage learners to reflect on their experiences and identify the reasons of failure and what could have been done differently Provide alternative explanations for negative emotions (frustration, self-confidence) for those struggling with completing task(s) Use peer modeling to help students see the task is not too hard or too easy Provide feedback that explains learners failed or succeeded based on effort and strategy use—not bad or good luck Encourage learners to identify strategies or processes that are reliable and suitable for them Use non-controlling language Provide meaningful cognitive support to help develop learner autonomy Encourage learners to identify their own learning needs, select learning strategies, and do a self-evaluation of their learning process and outcomes

* Depending on the context, some scaffolding examples might be applicable to more than one method.

Appendix B

Semi-Structured Interview Protocol

Thank you for agreeing to participate in the interview and for completing the pre-survey in advance. We appreciate you taking the time out of your busy schedule!

Please feel free to refer to the *Checklist for Scaffolding Methods* and/or *your survey responses* as needed throughout the interview.

Question	Notes
----------	-------

Conceptualization of Scaffolds

- What does scaffolding mean to you?
 - Probe: Explain scaffolding in your own words
 - Does your definition differ from the one we provided?
- How did you learn about scaffolding?
 - Probe: When did you first learn about it?
 - Probe: How was it taught or explained to you?
- How do you distinguish between a scaffold and a general resource?
- How do you differentiate between hard (preplanned) scaffolds and soft (just-in-time) scaffolds?

Designing and Implementing Scaffolds

Pre-planned (hard) scaffold

- Can you describe your process of designing or developing a scaffold?
 - Prompt: In that process
 - How did you identify the need for a scaffold?
 - How did you create it?
 - How did you implement it?
 - How do you see scaffolds supporting the needs of your students?

Just-in-time (soft) Scaffold

- Can you give an example of a time you implemented a scaffold in response to what your students were doing?
 - Prompt: In that process
 - How did you identify the need for a scaffold?
 - How did you create it?
 - How did you implement it?
 - How do you see scaffolds supporting the needs of your students?

PLEASE OPEN YOUR COURSE OR SHARE SCREENSHOTS FOR THIS SECTION

- Can you show us some examples of your scaffolds, pre-planned and the just-in-time varieties?
- Looking at our *Checklist for Scaffolding Methods*, can you describe and give an example of when you used these types of strategies?
- Do you often find that your soft or just-in-time scaffolds are turned into hard or planned scaffolds for future courses? Please describe
- Are there go-to scaffolds that you always use in your online courses, no matter what level or topic you teach?
- Do you host office hours? If so,
 - What type of resources/guidance are typical for that outlet?
 - Do you feel your office hours are related to scaffolding? Please describe

Scaffolding Variations

- (If applicable) How is scaffolding online different from scaffolding face-to-face?

Learner Outcomes/Performance/Measurement

- How do you know if a scaffold was successful?
 - How do you evaluate students' performance after implementing or providing a scaffold?
 - Are there cues you look for? What would be an example?

Challenges

- What challenges do you face when designing or implementing scaffolding?
 - In online settings
 - In general
- What do you do if a scaffold doesn't work the way you expected it would?
 - Can you provide an example?

Question	Notes
Tools	
<ul style="list-style-type: none"> • Think about the type of tools that you use when designing scaffolds. Can you list some of these? <ul style="list-style-type: none"> • Probe: For example, the tools that institution] provides like Kaltura, HotSeat, Piazza, etc • Probe: Tools that are not provided by [institution] such as padlet, YouTube, Drive platform, screencast, flipgrid 	

Closing out

- Is there anything else you would like to share that may be related to online course scaffolding that we have not discussed?

Acknowledgements We would like to extend our thanks to Arpit Bawa, Sarah Fehrman, and Sally Meech for their assistance in protocol development and data collection efforts for this research study.

Funding No funding was received to assist with the preparation of this manuscript.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Akerson, V. (2005). How do elementary teachers compensate for incomplete science content knowledge? *Research in Science Education*, 35, 245–268. <https://doi.org/10.1007/s11165-005-3176-8>
- Back, M., Han, M., & Weng, S. (2020). Emotional scaffolding for emergent multilingual learners through translanguaging: Case stories. *Language and Education*, 34(5), 387–406. <https://doi.org/10.1080/09500782.2020.1744638>
- Bannert, M., Hildebrand, M., & Mengelkamp, C. (2009). Effects of a metacognitive support device in learning environments. *Computers in Human Behavior*, 25(4), 829–835. <https://doi.org/10.1016/j.chb.2008.07.002>
- Belland, B. R. (2011). Distributed cognition as a lens to understand the effects of scaffolds: The role of transfer of responsibility. *Educational Psychology Review*, 23, 577–600. <https://doi.org/10.1007/s10648-011-9176-5>
- Belland, B. R., Kim, C., & Hannafin, M. (2013). A framework for designing scaffolds that improve motivation and cognition. *Educational Psychologist*, 48(4), 243–270. <https://doi.org/10.1080/00461520.2013.838920>
- Belland, B.R. (2014). Scaffolding: Definition, current debates, and future directions. In J. M. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of research on educational communications and technology* (pp. 505–518). Springer. https://doi.org/10.1007/978-1-4614-3185-5_39

- Belland, B. R., Walker, A. E., Kim, N. J., & Lefler, M. (2017). Synthesizing results from empirical research on computer-based scaffolding in STEM education: A Meta-Analysis. *Review of Educational Research*, 87(2), 309–344. <https://doi.org/10.3102/0034654316670999>
- Brush, T. A. & Saye, J. W. (2002). A summary of research exploring hard and soft scaffolding for teachers and learners using a multimedia supported learning environment. *The Journal of Interactive Online Learning*, 1(2), 1–12. <http://www.ncolr.org/jiol/issues/pdf/1.2.3.pdf>
- Chernikova, O., Heitzmann, N., Fink, M. C., Timothy, V., Seidel, T., & Fischer, F. (2019). Facilitating diagnostic competences in higher education: A meta-analysis in medical and teacher education. *Educational Psychology Review*, 32, 157–196. <https://doi.org/10.1007/s10648-019-09492-2>
- Cho, M., & Cho, Y. (2014). Instructor scaffolding for interaction and students' academic engagement in online learning: Mediating role of perceived online class goal structures. *The Internet and Higher Education*, 21, 25–30. <https://doi.org/10.1016/j.iheduc.2013.10.008>
- Cho, M., & Cho, Y. (2016). Online instructors' use of scaffolding strategies to promote interactions: A scale development study. *The International Review of Research in Open and Distributed Learning*, 17(6), 108–120. <https://doi.org/10.19173/irrodl.v17i6.2816>
- Dabbagh, N. (2003). Scaffolding: An important teacher competency in online learning. *TechTrends*, 47(2), 39–44. <https://doi.org/10.1007/bf02763424>
- Darby, F., & Lang, J. M. (2019). *Small teaching online: Applying learning science in online classes*. Jossey-Bass.
- Davidson-Shivers, G. V., Rasmussen, K. L., & Lowenthal, P. R. (2018). *Web-based learning* (2nd ed.). Berlin: Springer.
- Doo, M. Y., Bonk, C., & Heo, H. (2020). A meta-analysis of scaffolding effects in online learning in higher education. *The International Review of Research in Open and Distributed Learning*, 21(3), 60–80. <https://doi.org/10.19173/irrodl.v21i3.4638>
- Ertmer, P. A., & Glazewski, K. D. (2019). Scaffolding in PBL environments. In M. Moallem, W. Hung, & N. Dabbagh (Eds.), *The Wiley handbook of problem-based learning* (1st ed., pp. 321–342). Wiley-Blackwell, New York.
- Giacumo, L. A., & Savenye, W. (2020). Asynchronous discussion forum design to support cognition: Effects of rubrics and instructor prompts on learner's critical thinking, achievement, and satisfaction. *Educational Technology Research and Development*, 68, 37–66. <https://doi.org/10.1007/s11423-019-09664-5>
- Glazewski, K., & Hmelo-Silver, C. (2019). Scaffolding and supporting use of information for ambitious learning practices. *Information and Learning Sciences*, 120(1/2), 39–58. <https://doi.org/10.1108/ILS-08-2018-0087>
- Gormley, D. K., Colella, C., & Shell, D. L. (2012). Motivating online learners using attention, relevance, confidence, satisfaction motivational theory and distributed scaffolding. *Nurse Educator*, 37(4), 177–180. <https://doi.org/10.1097/nne.0b013e31825a8786>
- Hannafin, M., Land, S., & Oliver, K. (1999). Open learning environments: Foundations, methods, and models. In C. M. Reigeluth (Ed.), *Instructional-Design theories and models: A new paradigm of instructional theory* (Vol. 2, pp. 115–140). Lawrence Erlbaum Associates.
- Holden, H. K., & Sinatra, A. M. (2014). A guide to scaffolding and guided instructional strategies for ITs. In R. Sottolare, A. Graesser, X. Hu, & B. Goldberg (Eds.), *Design recommendations for intelligent tutoring systems* (Vol. 2, pp. 265–282). U.S. Army Research Laboratory.
- Huang, Y., & Huang, Y.-M. (2015). A scaffolding strategy to develop handheld sensor-based vocabulary games for improving students' learning motivation and performance. *Educational Technology Research and Development*, 63(5), 691–708. <https://doi.org/10.1007/s11423-015-9382-9>
- Kim, J. Y., & Lim, K. Y. (2019). Promoting learning in online, ill-structured problem solving: The effects of scaffolding type and metacognition level. *Computers and Education*, 138, 116–129. <https://doi.org/10.1016/j.compedu.2019.05.001>
- Luckin, R. (2008). The learner centric ecology of resources: A framework for using technology to scaffold learning. *Computers and Education*, 50(2), 449–462. <https://doi.org/10.1016/j.compedu.2007.09.018>
- Many, J. E. (2002). An exhibition and analysis of verbal tapestries: Understanding how scaffolding is woven into the fabric of instructional conversations. *Reading Research Quarterly*, 37(4), 376–407. www.jstor.org/stable/748259
- Mertzman, T. (2008). Individualising scaffolding: Teachers' literacy interruptions of ethnic minority students and students from low socioeconomic backgrounds. *Journal of Research in Reading*, 31(2), 183–202. <https://doi.org/10.1111/j.1467-9817.2007.00356.x>

- National Center for Education Statistics. (2019). *The condition of education 2019*. <https://nces.ed.gov/pubs2019/2019144.pdf>
- Neuman, D. (2014). Qualitative research in educational communications and technology: A brief introduction to principles and procedures. *Journal of Computing in Higher Education*, 26, 69–86. <https://doi.org/10.1007/s12528-014-9078-x>
- Oh, E., & Kim, H. (2016). Understanding cognitive engagement in online discussion: Use of a scaffolded, audio-based argumentation activity. *International Review of Research in Open and Distributed Learning: IRRODL*, 17(5), 28–48. <https://doi.org/10.19173/irrodl.v17i5.2456>
- Palmer, D. H. (2009). Student interest generated during an inquiry skills lesson. *Journal of Research in Science Teaching*, 46(2), 147–165. <https://doi.org/10.1002/tea.20263>
- Pea, R. (2004). The social and technological dimensions of scaffolding and related theoretical concepts for learning, education, and human activity. *Journal of the Learning Sciences*, 13(3), 423–451. https://doi.org/10.1207/s15327809jls1303_6
- Pifarre, M., & Cobos, R. (2010). Promotion metacognitive skills through peer scaffolding in a CSCL environment. *International Journal of Computer-Supported Collaborative Learning*, 5, 237–253. <https://doi.org/10.1007/s11412-010-9084-6>
- Reingold, R., Rimor, R., & Kalay, A. (2008). Instructor's scaffolding in support of student's metacognition through a teacher education online course: A case study. *Journal of Interactive Online Learning*, 7(2), 139–151.
- Reiser, B. J. (2004). Scaffolding complex learning: The mechanisms of structuring and problematizing student work. *Journal of the Learning Sciences*, 13(3), 273–304.
- Reiser, B., & Tabak, I. (2014). Scaffolding. In R. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 44–62). Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9781139519526.005>
- Roll, I., Butler, D., Yee, N., Welsh, A., Perez, S., Briseno, A., Perkins, K., & Bonn, D. (2018). Understanding the impact of guiding inquiry: The relationship between directive support, student attributes, and transfer of knowledge, attitudes, and behaviors in inquiry learning. *Instructional Science*, 46, 77–104. <https://doi.org/10.1007/s11251-017-9437-x>
- Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.) Sage.
- Sawyer, R. K. (2011). What makes good teachers great? The artful balance of structure and improvisation. In R. K. Sawyer (Ed.), *Structure and improvisation in creative teaching* (1st ed., pp.1–24). Cambridge University Press.
- Seaman, J. E., Allen, I. E., & Seaman, J. (2018). Grade increase: Tracking distance education in the United States. *Babson Survey Research Group*. <https://onlinelearningsurvey.com/reports/gradeincrease.pdf>
- Sharma, P., & Hannafin, M. J. (2005). Learner perceptions of scaffolding in supporting critical thinking. *Journal of Computing in Higher Education*, 17(1), 17–42.
- Sharma, P., & Hannafin, M. J. (2007). Scaffolding in technology-enhanced learning environments. *Interactive Learning Environments*, 15(1), 27–46. <https://doi.org/10.1080/10494820600996972>
- Shin, S., Brush, T., & Glazewski, K. (2017). Designing and implementing web-based scaffolding tools for technology-enhanced socioscientific inquiry. *Educational Technology & Society*, 20(1), 1–12.
- Simons, K. D., & Klein, J. D. (2007). The impact of scaffolding and student achievement levels in a problem-based learning environment. *Instructional Sciences*, 35, 41–72.
- Smallwood, A. M. K., & Brunner, B. R. (2017). Engaged learning through online collaborative public relations projects across universities. *Journalism and Mass Communication Educator*, 72(4), 442–460. <https://doi.org/10.1177/1077695816686440>
- Stavredes, T. (2011). *Effective online teaching: Foundations and strategies for student success*. New York: Wiley.
- Stavredes, T. M., & Herder, T. M. (2015). Student persistence- and teaching strategies to support it. In M. G. Moore (Ed.), *Handbook of distance education* (pp. 155–169). Routledge. <https://doi.org/10.4324/9780203803738.ch10>
- Tawfik, A., Law, V., Ge, X., Xing, W., & Kim, K. (2018). The effects of sustained vs. faded scaffolding on students' argumentation in ill-structured problem solving. *Computers in Human Behavior*, 87, 436–449.
- van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher-student interaction: A decade of research. *Educational Psychology Review*, 22, 271–296. <https://doi.org/10.1007/s10648-010-9127-6>

- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.
- Wood, D., Bruner, J., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Child Psychiatry*, 17, 89–100. <https://doi.org/10.1111/j.1469-7610.1976.tb00381.x>
- Yilmaz, F. G. K., & Yilmaz, R. (2019). Impact of pedagogic agent-mediated metacognitive support towards increasing task and group awareness in CSCL. *Computers & Education*, 134, 1–14. <https://doi.org/10.1016/j.compedu.2019.02.001>
- Yin, R. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks: Sage.
- Yin, R. (2018). *Case study research and applications: Design and methods* (6th ed.). Thousand Oaks: Sage.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors and Affiliations

Jennifer C. Richardson¹ · Secil Caskurlu² · Daniela Castellanos-Reyes^{1,3} · Suzhen Duan^{1,4} · Mohammad Shams Ud Duha^{1,5} · Holly Fiock^{1,6} · Yishi Long^{1,7}

¹ Department of Curriculum and Instruction, College of Education, Purdue University, Beering Hall, Room 3142, 100 North University Street, West Lafayette, IN 47907, USA

² Department of Counseling, Educational Psychology and Special Education, Michigan State University, East Lansing, MI 48824, USA

³ Department of Curriculum and Instruction, College of Education, Purdue University, Beering Hall, Room 3134, 100 North University Street, West Lafayette, IN 47907, USA

⁴ Department of Curriculum and Instruction, College of Education, Purdue University, Beering Hall, Room 3167, 100 North University Street, West Lafayette, IN 47907, USA

⁵ Department of Curriculum and Instruction, College of Education, Purdue University, Beering Hall, Room 3197, 100 North University Street, West Lafayette, IN 47907, USA

⁶ Department of Curriculum and Instruction, College of Education, Purdue University, Beering Hall, Room 3156, 100 North University Street, West Lafayette, IN 47907, USA

⁷ Department of Curriculum and Instruction, College of Education, Purdue University, Beering Hall, Room 3134, 100 North University Street, West Lafayette, IN 47907, USA