

A Theoretical Model of Peer Learning Incorporating Scaffolding Strategies

Jeeyoung Chun
University of Kentucky

Katherine Cennamo
Virginia Tech

Peer learning is a strategy designed to enable learners to become active learners. Previous research reveals that college students need support to learn the tasks of their roles in enhancing peer learning. The model of peer learning presented in this paper incorporates scaffolding strategies to design structured peer learning activities in a higher education setting. This model was developed based on the sociocultural theory of zone of proximal development, foundational concepts of scaffolding, as well as three dimensions for operationalizing scaffolding. It includes four steps: (a) knowing each other, (b) learning together, (c) checking what you learned, and (d) finalizing the peer learning. This model can assist peers in choosing the appropriate scaffolding tactics for peer learning. Moreover, guidelines in the model are beneficial for instructors who wish to enhance their skills in designing peer learning activities and training peers.

The current trajectory in higher education has been to move away from the traditional transmission-oriented approach to teaching and learning towards an interaction-oriented approach that shifts the focus onto the active role of the learners in learning (Fernandes & Flores, 2013). One of these approaches is peer learning, in which learners learn from other peers—a process that includes active learner involvement, in which the learner takes ownership for their education (Stone, Cooper, & Cant, 2013). In addition, peer learning is effective for learners to increase their learning outcomes, as well as psychological and social outcomes in higher education (Hanson, Trolan, Paulsen, & Pascarella, 2016).

Peer learning, despite its enormous potential, carries its own set of challenges in educational contexts. Previous researchers have shown that peers who are college students have sometimes lacked the needed skills or capability to assist in others' learning (Benè & Bergus, 2014). Because peers as educators are neither learner development experts nor skilled instructors, they need support to learn the tasks of their roles (Belland, 2017). Bell and Mladenovic (2015) also argued that professional development for peers is essential in assisting them with their teaching activities. Therefore, a structured peer learning environment should be provided to enhance both peers' teaching ability and learners' learning ability.

Previous researchers concerned with models of peer learning, with their focus on particular peer learning strategies, have stopped short of providing comprehensive guidance for the entire peer learning procedure. First, Webb (1989) developed a model of peer interaction based on questions for diverse types of problems, elaborations, and different learning outcomes. King (1997) proposed a model making use of a structured question sequence for knowledge-building activities. This model contains instructions for enhancing peers' supportive communication skills. Sevenhuysen et al. (2014) also presented a peer learning model that includes instructional tools to facilitate learners' peer learning activities. These existing models

of peer learning incorporate several peer learning strategies, such as question, elaboration, and observation. However, these models tend to concentrate on the development of feedback strategies for peer learning. A model for peer learning including an entire peer learning procedure, from diagnosis to examining learning outcomes, is required for the design of peer learning experiences in higher education. Therefore, to address this gap, a model of peer learning is developed in this study to provide peers with guidance to design complete peer learning activities that include setting learning goals, specific peer learning strategies, evaluation processes, and finalizing peer learning in higher education settings.

Scaffolding is a useful tactic to include in peer learning since it involves various feedback strategies, a learning process from setting a goal to an assessment, and a specific role for the peer. Scaffolding is defined as “a process or technique through which a teacher or more knowledgeable peer adds supports for learners in order to enhance learning or facilitate the mastery of tasks” (Kaoropthai, Natakatoong, & Cocharojanane, 2019, p. 135). Through scaffolding, a peer can help to develop and expand another learner's knowledge to a more advanced level via demonstrating learning abilities and experiences (Williams & Burden, 2000).

This paper discusses the role of scaffolding in peer learning and reviews literature regarding the theoretical foundations of scaffolding. The reviewed literature covers related theories such as sociocultural theory and the zone of proximal development (ZPD), the conceptualization of scaffolding, and three dimensions for operationalizing scaffolding, including the level of scaffolding, the type of scaffolding, and scaffolding methods. In light of the reviewed literature, a model of peer learning incorporating scaffolding strategies is described to provide instructors and peers who are college students with guidance in designing peer learning activities in higher education. Finally, this paper concludes with a discussion of the implications and limitations of the model.

The Role of Scaffolding in Peer Learning

Empirical studies conducted in a variety of content areas have highlighted the importance of scaffolding in peer learning (De Guerrero & Villamil, 2000; Lin & Samuel, 2013; Morcom, 2016). Scaffolding has been recognized as serving three major roles for peer learning.

Scaffolding in a peer learning setting is used to equip learners with appropriate learning strategies. Among peer learners of lesser or greater ability, scaffolding is a cooperative effort aimed at assisting one another not only by sharing materials to alter or broaden perspectives but also by stimulating peers' thoughts (Aryal & Zollman, 2007). For example, in a study of a writing class, Lin and Samuel (2013) observed that modifying learners' inaccuracies and the use of inquiries are effective forms of scaffolding in peer learning environments. They found that these supports offered by the peer in adjusting for mistakes are well-received as a learning procedure for all their participants. In a study of language learning, Cotterall (1990) found that four types of processes help novice learners. First, learners are acquainted with general or specific modelling from a knowledgeable person; second, they have hints to learn new tactics; third, they have abundant chances to argue and perform the new approaches, and finally, they have prompt advice about their learning activities. These strategies effectively lessen the learning load for class participants as they take part in what is an unfamiliar and thought-provoking activity (Cotterall & Cohen, 2003).

The use of scaffolding within peer learning has provided learners with opportunities to build mutually beneficial relationships with each other. As learners mutually exchange assistance through scaffolding and the learning task becomes more balanced, new information is acquired and shared (De Guerrero & Villamil, 2000). In a study of a social studies classroom, Morcom (2016) pioneered the concept of whole-class scaffolding to utilize the shared information resulting from peer interaction and build reciprocal respect to lessen antisocial actions. These findings indicated that scaffolding can promote peer interaction to form positive rapport and reciprocal respect in a peer learning environment. In addition, in a study of a business class, Matthewman, Nowlan, and Hyvönen (2018) found that the effectiveness of scaffolding in peer learning is reciprocal. They proposed that peer learning using scaffolding assists learners in forming a safe learning environment where ideas can be exchanged with peers. Learners can share their viewpoints and knowledge to support the development of new capabilities and understanding with their peers.

Scaffolding also helps learners enhance problem-solving skills in peer learning. Scaffolding is utilized in a learning environment in which a peer helps another learner to achieve a learning task or to resolve a problem

that he/she is not able to complete alone (Rahmani, Abbas, & Alahyarizadeh, 2013). For example, in instructional psychology and technology classes, Xie and Bradshaw (2008) examined the impact of question prompts and peer collaboration in the process of solving ill-structured problems. The findings indicated that learners who use question prompts show better performance during the problem-solving process than the learners who study without question prompts. Ge and Land (2003) also studied the effectiveness of peer learning and question prompts for scaffolding college learners' problem-solving procedures but in information sciences and technology classes. The results showed that question prompts had significantly positive impacts on learners' problem-solving activities, and peer learning promoted metacognitive abilities and cognitive reasoning for problem-solving.

The Theoretical Underpinning of Scaffolding in Peer Learning

The concept of the zone of proximal development (ZPD) is considered as the theoretical foundation of scaffolding (Belland, 2014; Frank, Simper, & Kaupp, 2018; Puntambekar, 2015; Van de Pol, Mercer, & Volman, 2019; Wischgoll, Pauli, & Reusser, 2015). ZPD is defined as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). In ZPD, learning activities are more challenging than those which learners can do without help, such that they will need to learn together with either a more capable peer or an instructor (Morgan, 2014). As the learners complete their learning without any assistance, their ZPD decreases (Lee & Hannafin, 2016).

Scaffolding is the representational structure of ZPD (Minson, Hammer, & Veresov, 2016). It is a pedagogical process that allows learners to solve their problem, perform an activity, or attain a purpose that would be above their unaided ability, thereby advancing their zone of proximal development (Purnakanishtha, Suwannathachote, & Nilsook, 2014). Van de Pol et al. (2019) regard the ZPD transmission of responsibility to the learner as the main purpose of scaffolding in teaching contexts. Scaffolding operates most efficiently when it is adapted to the learner, adjusted, and finally removed according to the learner's maturation (Loparev & Egert, 2015). If scaffolding is fruitful, the ZPD will recede as the learner becomes able to accomplish an activity without assistance (Belland, 2014).

Sociocultural theory highlights social and cultural interaction to facilitate an individual's cognitive growth and development (Ryu & Lombardi, 2015). The

conception of the notion of scaffolding is characterized by three central features of sociocultural theory: (a) social procedure, (b) mediation, and (c) appropriation (Turner & Berkowitz, 2005).

A social procedure is essential to providing scaffolding to learners to attain a high level of capability through interactions with others. Sociocultural theory insists that studying, considering, and comprehending are relationships among persons in action in, with, and rising from a culturally and socially organized field (Wang, 2007). Thus, learning is mutually shaped by the members in an organized discussion in which the more proficient participant encourages the learning of the less able participant(s) by constructing, and steadily dismantling, a scaffold within which the learner is able to make progress from their current level of competence to a higher degree of capability (Barnard & Campbell, 2005).

Mediation through humans and symbols is a collaborative interaction through which to construct scaffolding. Sociocultural theory includes an assertion that the human mind is intermediated through the human and the symbolic (Shabani, 2016). Vygotsky (1978) argues that mediation is the part performed by other important individuals in the learner's life: individuals who improve their learning by choosing and forming the learning activities demonstrated to them. On the other hand, people utilize signals, symbols, or instruments to study and to adjust their action (Barnard & Campbell, 2005). Mediation is a cooperative and interactive social exercise in which problem-solving is completed, much like the cooperative interaction defined in scaffolding (Boblett, 2012).

Appropriation is related to transferring responsibilities, which is the main function of scaffolding. Appropriation is a procedure of transformation from intermental to intramental working (Black & Allen, 2018). Appropriation happens as persons—frequently with others, and constantly in the setting of sociocultural movement—figure out how to deal with a new circumstance based on their individual and shared histories to attain both their own and their common purpose (Rogoff, 1993). Learning takes place only when this comprehension is appropriated by the person (Barnard & Campbell, 2005). The notion of appropriation is revealed in eliminating the scaffolding as learners effectively navigate through a learning activity (Boblett, 2012).

The Conceptualization of Scaffolding

The Characteristics of Scaffolding

Scaffolding may have many diverse definitions, but they share some common features: intersubjectivity, the role of the scaffolder, ongoing diagnosis and calibrated

support, and fading (Davis, 2015; Pea, 2004; Puntambekar & Hubscher, 2005; Stone, 1998; Van de Pol et al., 2010).

Intersubjectivity refers to a temporary, commonly shared comprehension or framework among participants in learning activities (Bonk & Cunningham, 1998). As learners discover their shared background (Rogoff, 1990) or commonly held opinions (Levine & Moreland, 1991), they can more comfortably discuss their views, negotiate discussed meanings, and construct new knowledge (Bonk & Cunningham, 1998). Intersubjectivity is obtained when the peer and learner collaboratively outline the activity again to obtain mutual ownership of the it, at which time the learner should display an understanding of the objective (Puntambekar & Hubscher, 2005). In order to gain the learner's attention, the task should be sufficient to the learner's comprehension, and there should be initial common understanding of the work conditions, however restricted it may be with regards to the perception of the work to be accomplished (Stone, 1998). In other words, initial and continuing cooperative participation is crucial, though the activity assigns different tasks to each participant (Stone, 1998). The peer's responsibility is to ensure that the learner is participating in the activity as well as to provide motivation, making it meaningful for the learner to take risks necessary to reach the next stage (Wood, Bruner, & Ross, 1976).

The peer as a scaffolder must recognize where the learner is having difficulties and then offer assistance (Bull et al., 1999). Therefore, assistance should be based on the present level of the learner's ability, while the peer should have knowledge either at a similar or a slightly advanced level as that of the learner (Van de Pol et al., 2010). This requires that the peer have a clear idea not only of the learner's abilities but also of the activity and the specific objectives it aims to complete (Puntambekar & Hubscher, 2005). In effective scaffolding, peers assist, encourage, and facilitate learners' task levels (Granott, 2005). The peer draws from a repertoire of tactics to offer assistance, continually adjusting the assistance offered according to the learner's changing abilities and understanding (Puntambekar & Hubscher, 2005).

The ongoing diagnosis promotes a cautious calibration of assistance so that the peer is able to supply graduated support (Puntambekar & Hubscher, 2005; Stone, 1998). It is the collaborative and dialogic feature of scaffolded education that makes this ongoing diagnosis and adjustment possible (Puntambekar & Hubscher, 2005). The interlocutory interactions enable the peer to conduct a constant evaluation of the learner's comprehension and enable the learner to take part in negotiating the collaborations (Puntambekar & Hubscher, 2005).

Fading refers to adjustments in the role, level, or extent of assistance being offered, allowing the learner

to take ownership of the activity (Davis, 2015). The peer fades scaffolding for learners based on personalized calibration and assessment (Davis, 2015). The degree of fading depends on the learner’s level of improvement and capability (Van de Pol et al., 2010). When the learner comprehends the specific task, the expert diminishes (or fades) their involvement, offering only restricted cues, modifications, and responses to the learner, who gradually reaches the goal through a smooth performance (Pea, 2004). Through fading, responsibility for the activity is progressively shifted to the learner (Van de Pol et al., 2010). Responsibility is defined as learners’ metacognitive or cognitive tasks, or their affect (Van de Pol et al., 2010). According to Wood et al. (1976), an essential aspect of the transfer of responsibility is that the learner not only arrives at an understanding of how to complete a particular activity, but also abstracts the procedure into general comprehension, in order to apply the knowledge to similar activities.

The Concept of Scaffolding

Based on the results of the literature review regarding the characteristics of scaffolding, the concept of scaffolding was synthesized as illustrated in Figure 1. To conduct the scaffolding process, the peer and the learner figure out common goals and the learner’s current and potential abilities through the first diagnosis. ZPD is utilized to examine students’ current and intended capabilities for scaffolding (Li, 2015). Based on the first diagnosis, the peer begins the problem-solving by helping the learner ascertain the objective structure of the problem (Bull et al., 1999).

The peer provides instructions to assist learners’ problem-solving activities. The peer should attempt to

estimate the suitable level of scaffolding so that the learner is studying simply and carrying a low cognitive load (Bull et al., 1999). The learner should be involved in a continuing procedure of conversational reasoning as a means of understanding the peer’s statements or activities, taking into consideration both statements and activities to fuel progress (Stone, 1998).

Ongoing assessments are conducted to correct scaffolding strategies based on learners’ current capabilities. A peer is continuously assessing the learner’s development to recognize the learners’ present knowledge and to offer assistance that is suitable for the learner (Calder, 2015). Diagnosis leads to interactions that differ in style and content from person to person, and for the same person at diverse periods (Puntambekar, 2009).

Scaffolding is reduced when learners accomplish learning tasks. If the learners attain understanding, the peer is able to fade the assistance over time (Weng, Lin, & She, 2017). While lessening the assistance, the peer is able to transfer accountability to the learner so that the learner will have the opportunity to manage their own learning (Van de Pol et al., 2010). Fading of scaffolding ultimately provides learners with a chance to accomplish the work by themselves (Vrieling, Stijnen, & Bastiaens, 2018).

Three Dimensions for Operationalizing Scaffolding for Peer Learning

To operationalize scaffolding, three dimensions of scaffolding are presented to explain different phases of scaffolding. These three dimensions include the level of scaffolding, the type of scaffolding, and scaffolding methods (See Figure 2.).

Figure 1
Visual Conception of Scaffolding

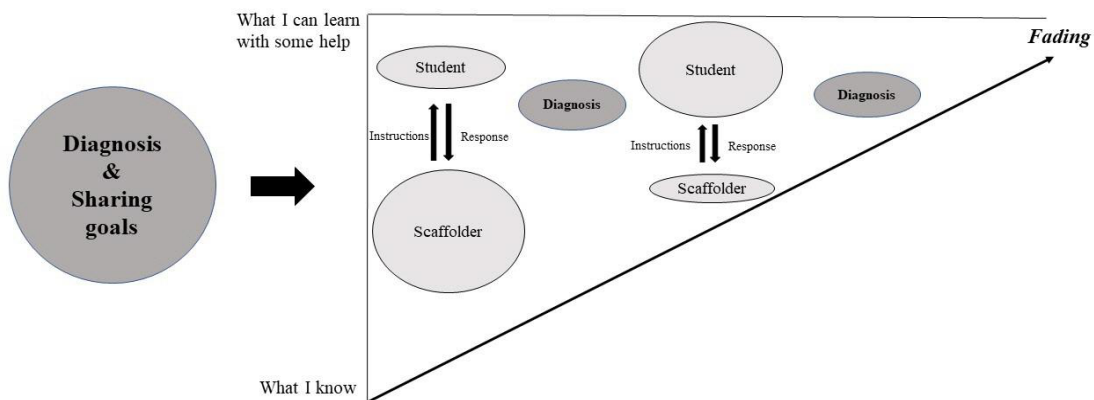
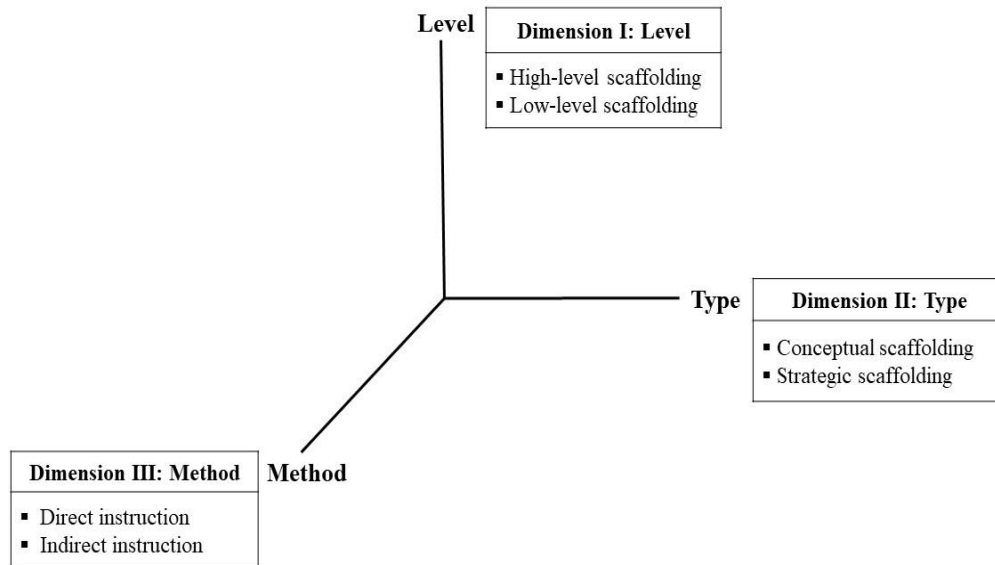


Figure 2
Three Dimensions of Operationalizing Scaffolding



In the first dimension, two levels of scaffolding—high-level and low-level—are suggested to investigate appropriate scaffolding strategies based on learners' characteristics (See Table 1). The second dimension includes two types of scaffolding: conceptual scaffolding and strategic scaffolding. The third dimension describes six scaffolding methods to provide specific peer teaching strategies.

Dimension I: Level of Scaffolding

The first dimension for operationalizing scaffolding is the level of scaffolding. Too much scaffolding could lessen learners' enthusiasm, causing decreased ambition toward self-directed learning and meaning-making activities (Dabbagh, 2003). In contrast, insufficient scaffolding could negatively affect learners' capability to succeed at specific activities, inducing annoyance, anxiety, and eventually reduction of motivation (Dabbagh, 2003). Therefore, peers need to figure out learners' characteristics and utilize suitable scaffolding strategies based on their determination of the appropriate level of scaffolding.

High-level Scaffolding

High-level scaffolding is utilized when learners represent low prior knowledge, have few cognitive tactics, high apprehension, low engagement, and an external locus of control (Smith & Ragan, 1999). In a learning setting in which high-level scaffolding is needed, supplementary tactics are commonly more

appropriate (Dabbagh, 2003). For example, the peer is providing all or most of the learning objectives, explanations, sequencing, structure, and highlighting of the subject, as well as assessing and checking learners' learning and presenting recommendations for transmission of information to other subjects (Smith & Ragan, 1999).


Low-level Scaffolding

Low-level scaffolding is supplied when matured learners possess high prior knowledge, various cognitive tactics, malleable and high motivation, and low concern (Dabbagh, 2003; O'Connor, Notari-Syverson, & Vadasy, 2005). In an educational setting in which low-level scaffolding is required, generative approaches—such tactics as generalizing, logical thinking, and forecasting—can be encouraged or adopted (Pentimonti & Justice, 2010). The learner and the peer are both assisting teaching and learning procedures where control is equalized or dispersed amongst learners, peers, and the learning results (Dabbagh, 2003).

Dimension II: Types of Scaffolding

Scaffolding strategies have a different function based on the type(s) of scaffolding in use. Peers need to select scaffolding tactics according to an appropriate function. In dimension II, two types of scaffolding—conceptual scaffolding and strategic scaffolding (Hannafin, Land, & Oliver, 1999)—are adopted in exploring the purposes of scaffolding.

Table 1
Features of the Two Levels of Scaffolding

	Learner’s Characteristics	Scaffolding Strategies
	High-Level Scaffolding <ul style="list-style-type: none"> • Low prior knowledge • Few cognitive tactics • High apprehension • Low engagement • An external locus of control (Smith & Ragan, 1999) 	<ul style="list-style-type: none"> • Supplementary tactics <ul style="list-style-type: none"> - Providing instructions - Assessing learners’ learning - Presenting recommendations (Smith & Ragan, 1999)
	<ul style="list-style-type: none"> • High prior knowledge • Various cognitive tactics • Low concern • Malleable and high motivation • An internal locus of control (Dabbagh, 2003) 	<ul style="list-style-type: none"> • Generative tactics <ul style="list-style-type: none"> - Generalizing - Logical thinking - Forecasting (Pentimonti & Justice, 2010)
Low-Level Scaffolding		

Conceptual Scaffolding

Conceptual scaffolding provides assistance for the learner to choose to prioritize what is essential or what to contemplate (Waiyakoon, Khlaisang, & Koraneekij, 2015). This type of scaffolding helps learners find solutions to complicated problems, recognize the main ideas and notions related to the learning activity, and correct common misapprehensions (Quaye & Harper, 2015). Conceptual scaffolding can be made available via various mechanisms, from the graphical description of relations among notions to knowledge and clues suggested by masters to frameworks illustrating ordinate-subordinate relationships (Hannafin et al., 1999; Kim, Belland, & Walker, 2018).

Strategic Scaffolding

Strategic scaffolding provides learners with alternate perspectives or skills for studying or recommendations for original questions (Sottolare, Graesser, Hu, & Goldberg, 2014). Through strategic scaffolding, learners can identify and assess information, as well as receive guidance to find an appropriate tactic for problem-solving (Quaye & Harper, 2015). Scaffolding helps learners choose required information and assess available materials (Hannafin, Hannafin, McCarthy, & Radtke, 2001). Strategic scaffolding also includes introducing the learners to available devices and materials that are useful under given learning environments, as well as guidance in their usage (Hannafin et al. 2001).

Dimension III: Scaffolding Methods

The third dimension of scaffolding is scaffolding methods. Scaffolding methods are utilized to provide learners with specific guidance to implement scaffolding (Duffy & Azevedo, 2015). It consists of both direct instructions and indirect instructions. Indirect instructions may include hints, questioning, or prompting, while direct instructions may include offering feedback, explanation, and modeling.

Indirect Instructions

Hints are suggested with each reminder to provide learners with clues about the types of ideas they should examine and express in their reasoning (Owensby & Kolodner, 2004). By proposing certain methods of responding to any impediments that may arise, these hints can potentially encourage effort regulation by learners (ter Beek et al., 2019).

Questioning is a traditional scaffolding technique that peers can use for examining organization, scheduling, checking, assessing, and making rationalizations (Ge & Land, 2003). Questioning helps learners engage in their learning activities and facilitates inferences from the interaction (Kim et al., 2018). Questions also enable peers and learners to make up their knowledge deficiencies and monitor each other’s comprehension (Thompson & Mackiewicz, 2014).

Prompting is utilized in learning settings to stimulate learning activities and to facilitate reflection regarding learning tasks (Blunk & Prilla, 2015). Prompting helps learners clarify their problem-solving

procedures (Chen & Law, 2016). Prompting is useful for scaffolding learners' higher-order thinking abilities, self-questioning, self-monitoring/ reflection, and self-explaining (Lee, Chen, & Chang, 2014).

Direct Instructions

Feedback includes the providing of knowledge related to the learner's capability (Kim et al., 2018). Effective feedback not only offers explicit instructions for learners on how to improve their learning but also helps them comprehend the subject matter they are attempting to learn (Huang, Chen, Wu, & Wei-Yu, 2015). According to Frank et al. (2018), learners improve their learning outcomes through new feedback and scaffolding.

The explanation consists of declarations that account for the learner's emerging comprehensions about declarative or propositional knowledge, procedural knowledge, and conditional or situational knowledge (Hogan & Pressley, 1997). This type of assistance is used to improve learners' knowledge and enhance their comprehension (Yantraprakorn, Darasawang, & Wiriyakarun, 2013). Legare and Lombrozo (2014) found that explanation facilitates

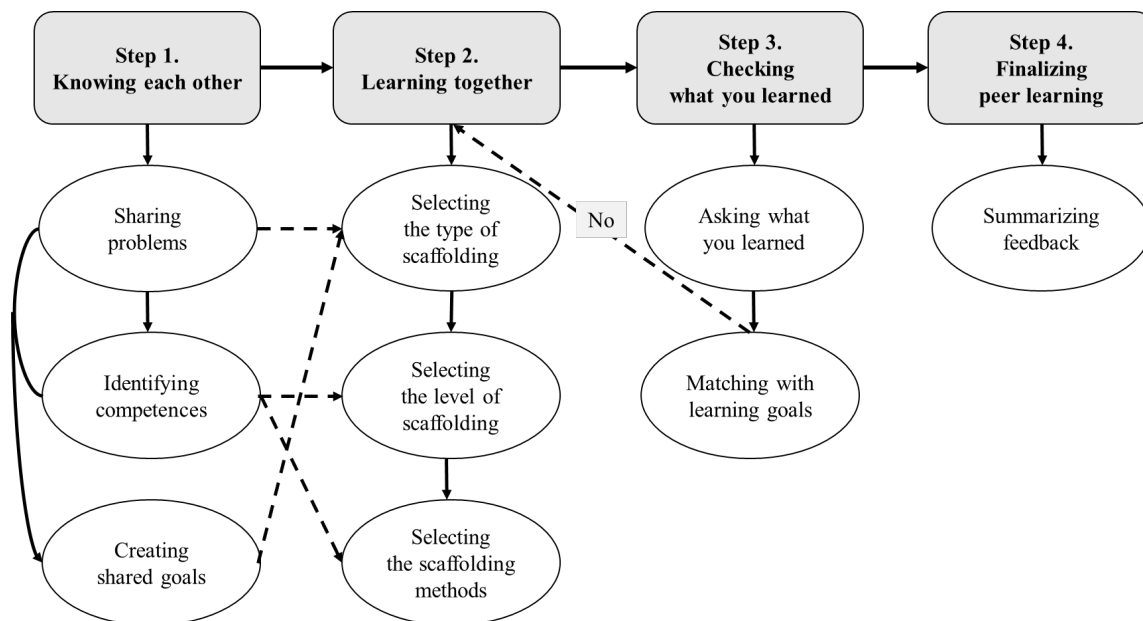
casual studying and generalization of broad patterns.

Modeling is demonstrating for learners directly by stating what a specialist would do when confronted with a comparable problem (Belland, 2014). Successful scaffolding includes modeling so that learners can observe and study process abilities, thinking abilities, and problem-solving abilities (Tan, 2004). Yi, Plucker, and Guo (2015) demonstrated a significant enhancement in learners' divergent thinking and artistic creativity when modeling was provided.

Development of a Model of Peer Learning Incorporating Scaffolding Strategies

Based on the principles of sociocultural theory and ZPD, the conceptualization and operationalization of scaffolding, and related research, a synthesized model of peer learning incorporating scaffolding is presented here. Within a peer learning environment, one learner serves as the peer, who provides the scaffolding, while the other learner is the learner. Design strategies and relevant literature are described to assist the peers and the learners to use appropriate scaffolding strategies in peer learning environments. Figure 3 presents the steps and guidelines of the model.

Figure 3
The Model of Peer Learning Incorporating Scaffolding Strategies



Step 1: Knowing Each Other

For the first step, peers recognize learners' problems or concerns regarding their problem-solving activities in peer learning. Peers also ask learners about their prior knowledge and their skills related to these problems. Based on their problems and competences, peers and learners set learning goals to start peer learning activities.

1.1. Sharing Problems

Peers identify learners' specific problems or concerns before starting with peer learning. Bull et al. (1999) argued that peers can initiate the problem-solving activity through finding the learners' problems. Their problems would then become the foundation for designing a peer learning process. Peers estimate learning activities and required knowledge to solve their problems once learners identify their problems or concerns.

1.2. Identifying Competences

Peers ask learners about their current level of comprehension regarding their problems or concerns. According to Obikwelu, Read, and Sim (2012), learner profiling is the starting point for the scaffolding cycle. The main task of learner profiling is finding a learner's initial competence and target competence, which are related to the notion of ZPD. This is important because the learner's initial competence in relation to the required competence is vital to the determination of the level of guidance required by the learner.

1.3. Creating Shared Goals

When the peer and the learner find problems and a target competence, they should set up ultimate goals in order to have common purposes. Setting goals is related to intersubjectivity, which is a characteristic of scaffolding. According to Adenowo and Patel (2014), intersubjectivity is attained when the peer and the learner share an understanding of the goal that they need to accomplish. Through setting up shared goals, peers facilitate self-regulated development of the learner (Diaz, Neal, & Amaya-Williams, 1990).

Step 2: Learning Together

The second step aims to guide peers to use appropriate scaffolding strategies based on a learner's current ability and the characteristics of problems. When the peers choose scaffolding strategies, they consider the level of scaffolding, the type of scaffolding, and scaffolding methods.

2.1. Selecting the Type of Scaffolding

Peers select the type of scaffolding based on the characteristics of the learner's problems. Conceptual scaffolding is utilized to help learners understand important concepts or notions related to their problems (Hsiao, 2017). Peers can use strategic scaffolding to find alternative ways for studying (Stavredes & Herder, 2014). For example, peers may use a concept map when learners are struggling to understand important notions. Peers may also suggest available resources for learners to find alternative approaches for their problem-solving.

2.2. Selecting the Level of Scaffolding

Peers decide on an appropriate level of scaffolding based on the learners' current capabilities and their degree of motivation. High-level scaffolding is selected for learners who show low prior knowledge and motivation (Smith & Ragan, 1999). In contrast, when the learner demonstrates high prior knowledge and motivation, low-level scaffolding is offered (Dabbagh, 2003). The level of scaffolding plays a key role in deciding specific scaffolding methods.

2.3. Selecting the Scaffolding Methods

Based on the level of scaffolding, scaffolding methods are selected to provide detailed instructions. Among scaffolding methods, indirect instructions—hints, questioning, and prompting—are utilized to provide low-level scaffolding, since these instructions facilitate the learner's reasoning (Lee et al., 2014). To provide high-level scaffolding, the peer uses direct instructions such as offering feedback, explanation, and modeling. Direct instructions provide learners with detailed guidance and demonstrations (Yantraprakorn et al., 2013).

Step 3: Checking What You Learned

The third step is to help peers assess learners' learning progress during peer learning activities. Through ongoing assessments, peers identify learners' current learning progress and revise their instructions. When learners achieve their learning goals, peers finish peer learning activities.

3.1. Asking What You Learned

Assessments are conducted to figure out learners' progress during peer learning activities. According to Nordlof (2014), peers must evaluate the learners' improvement and modify scaffolding strategies when required. For example, peers observe and assess whether or not learners understand concepts important to solving

the problem. If learners do not understand them, peers use conceptual scaffolding and direct instructions to assist the learners' comprehension. If learners understand all concepts, peers can use indirect instruction or another type of scaffolding.

3.2. Matching with the Learning Goals

When the learner achieves the learning goals, peers can remove their scaffolding activities. Before fading scaffolding, the peer assesses the learner's learning progress based on the learning goals. The purpose of scaffolding is ultimately to remove the need for support and reduce the level of assistance when the learners enhance their learning capability (De Backer, Van Keer, & Valcke, 2016). Thus, fading is critical for finalizing scaffolding strategies (Davis, 2015).

Step 4: Finalizing Peer Learning

The fourth step is to finalize the peer learning by summarizing the provided feedback at the end of the peer learning activity. Peers and learners confirm important concepts or strategies during their peer learning activities and find disregarded problems before concluding the peer learning activities.

4.1. Summarizing Feedback

Peers provide learners with summarized feedback to wrap up peer learning activities. Summary feedback can be utilized to examine whether the learner's actual ability is the same as the anticipated ability (Nelson & Schunn, 2009). Through providing summary feedback, the peer finally checks the learner's ability and provides a final opportunity to find an unnoticed issue before finishing the peer learning activity. When the peer and the learner do not have any issues after sharing summary feedback, they finish the peer learning activities.

Conclusion

In this paper, a model of peer learning that incorporates scaffolding strategies is described for higher education environments. The model has been developed based on a literature review regarding the theoretical foundations, conceptualization, and operationalization of scaffolding as well as a consideration of the role of scaffolding in peer learning. The model is regarded as a conceptual model. A conceptual model is defined as "a model that represents the important variables and relationships between variables in the design of instruction to provide a macro-level perspective of an instructional design task" (Lee & Jang, 2014, p. 747). As a conceptual model, this model was developed using the characteristics of scaffolding

and their relationships. This model consists of the identified main characteristics of scaffolding, such as calibrated support, ongoing diagnosis, and fading, and synthesizes a peer learning process based on their interrelationships.

This conceptual model may be used to suggest specific guidelines and strategies that will be helpful to peers and instructors in higher education. First, peers can design a peer learning environment where they are able to select appropriate scaffolding strategies that enable learners to achieve learning goals through receiving suitable guidance in an authentic process of peer learning. This model exists to help peers understand the main features and concepts of scaffolding and figure out how to use these concepts in a peer learning environment. Secondly, guidelines in the model of peer learning are beneficial for the instructors themselves to provide structured peer learning activities while implementing peer learning in their classes. Instructors can apply the model of peer learning to enhance their designing skills regarding peer learning activities, as well as to provide peers with training before starting peer learning in their class.

Yet, there are limitations and implications to be considered in future studies. Although the model was developed based on the findings of a literature review, a model validation process (Richey & Klein, 2014) is required to prove the components and procedures of the model for future use. The model validation process includes both internal validation to validate all the components and processes as well as external validation to examine the effectiveness of the model in a real peer learning setting. Moreover, before adopting the model to design peer learning activities, peers will need to learn the steps and strategies of the model. They should learn all specific scaffolding tactics through the model to conduct and design peer learning activities for higher education. Based on our experiences, the peers may be able to learn the four steps, including scaffolding strategies, in as little as 10-15 minutes, but this will need to be confirmed in future studies. Instructors could explain the model using text and video descriptions and give students electronic instructions for proceeding through the four steps of the model. To provide specific instruction for the use of the model in a subject peers will teach, instructors may need to demonstrate how to apply this model to that subject. Finally, it is assumed that peers should be people who are more advanced and experienced in the relevant skills, yet who have equal status in the same school as the learners with whom they work. The model can be utilized for all peer learning activities in higher education; however, before implementing the model in a course, instructors should identify learners with advanced skills who could help guide other learners. If instructors could not find more knowledgeable learners to act as peers, techniques to

support self-directed learning may need to be used rather than a model of peer learning. In that case, instructors need to give the learners guidance so that they can establish learning goals among themselves, select the appropriate strategies, and find explanations or demonstrations using the Internet and other available resources.

Disclosure Statement

No potential conflict of interest was reported by the authors.

Acknowledgments

This manuscript represents part of the dissertation the first author submitted in the Instructional Design and Technology program at Virginia Polytechnic Institute and State University.

References

- Adenowo, A. A. A., & Patel, A. M. (2014). Metamodel for designing and intelligent tutoring systems authoring tool. *Computer and Information Science*, 7, 82-98.
- Aryal, B., & Zollman, D. A. (2007). Investigating peer scaffolding in learning and transfer of learning using teaching interviews. In L. Hsu, C. Henderson, & L. McCullough (Eds.), *AIP Conference Proceedings* (pp. 37-40). AIP.
- Barnard, R., & Campbell, L. (2005). Sociocultural theory and the teaching of process writing: The scaffolding of learning in a university context. *The TESOLANZ Journal*, 13, 76-88.
- Bell, A., & Mladenovic, R. (2015). Situated learning, reflective practice and conceptual expansion: effective peer observation for tutor development. *Teaching in Higher Education*, 20(1), 24-36.
- 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.
- Belland, B. R. (2017). Instructional scaffolding: foundations and evolving definition. In *Instructional Scaffolding in STEM Education* (pp. 17-53).
- Benè, K. L., & Bergus, G. (2014). When learners become teachers. *Family Medicine*, 46, 783-787.
- Black, S., & Allen, J. D. (2018). Part 5: Learning is a social act. *The Reference Librarian*, 59(2), 76-91.
- Blunk, O., & Prilla, M. (2015). Prompting users to facilitate support needs in collaborative reflection. In M. Kravcik, A. Mikroyannidis, V. Pammer, M. Prilla, & T. D. Ullmann (Eds.), *Proceedings of the 5th Workshop on Awareness and Reflection in Technology Enhanced Learning* (pp. 43-57). CEUR Workshop Proceedings.
- Boblett, N. (2012). Scaffolding: Defining the metaphor. *Working Papers in TESOL & Applied Linguistics*, 12(2), 1-16.
- Bonk, C. J., & Cunningham, D. J. (1998). Searching for learner-centered, constructivist, and sociocultural components of collaborative educational learning tools. *Electronic Collaborators: Learner-Centered Technologies for Literacy, Apprenticeship, and Discourse*, 25, 25-50.
- Bull, K., Shuler, P., Overton, R., Kimball, S., Boykin, C., & Griffin, J. (1999). Processes for developing scaffolding in a computer mediated learning environment. In *Rural special education for the new millennium* (ERIC Document Reproduction Service No. ED 429765).
- Calder, N. (2015). Student wonderings: Scaffolding student understanding within student-centred inquiry learning. *ZDM*, 47(7), 1121-1131.
- Chen, C. H., & Law, V. (2016). Scaffolding individual and collaborative game-based learning in learning performance and intrinsic motivation. *Computers in Human Behavior*, 55, 1201-1212.
- Cotterall, S. (1990). Developing reading strategies through small-group interaction. *RELC Journal*, 21(2), 55-69.
- Cotterall, S., & Cohen, R. (2003). Scaffolding for second language writers: producing an academic essay. *ELT journal*, 57(2), 158-166.
- Dabbagh, N. (2003). Scaffolding: An important teacher competency in online learning. *Tech Trends*, 47(2), 39-44.
- Davis, E. A. (2015). Scaffolding learning. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (pp. 845-847). Springer.
- De Backer, L., Van Keer, H., & Valcke, M. (2016). Eliciting reciprocal peer-tutoring groups' metacognitive regulation through structuring and problematizing scaffolds. *The Journal of Experimental Education*, 84(4), 804-828.
- De Guerrero, M. C., & Villamil, O. S. (2000). Activating the ZPD: Mutual scaffolding in L2 peer revision. *The Modern Language Journal*, 84(1), 51-68.
- Diaz, R., Neal, S., & Amaya-Williams, M. (1990). Social origins of self-regulation. In L. C. Moll (Ed.), *Vygotsky and Education: Instructional Implications and Applications of Sociocultural Psychology* (pp. 127-154). Cambridge University Press.
- Duffy, M. C., & Azevedo, R. (2015). Motivation matters: Interactions between achievement goals and agent scaffolding for self-regulated learning within an intelligent tutoring system. *Computers in*

- Human Behavior*, 52, 338-348.
- Fernandes, S., & Flores, M. A. (2013). Tutors' and students' views of tutoring: a study in higher education. In M.A. Flores, A. A. Carvalho, F. I. Ferreira, & M. T. Vilaça (Eds.), *Back to the Future: Legacies, Continuities and Changes in Educational Policy, Practice and Research* (pp. 277–295). Sense Publishers.
- Frank, B., Simper, N., & Kaupp, J. (2018). Formative feedback and scaffolding for developing complex problem solving and modelling outcomes. *European Journal of Engineering Education*, 43(4), 552-568.
- Ge, X., & Land, S. M. (2003). Scaffolding students' problem-solving processes in an ill-structured task using question prompts and peer interactions. *Educational Technology Research and Development*, 51(1), 21-38.
- Granott, N. (2005). Scaffolding dynamically toward change: Previous and new perspectives. *New Ideas in Psychology*, 23(3), 140–151.
- Hannafin, M. J., Hannafin, K. M., McCarthy, J. E., & Radtke, P. (2001). Scaffolding performance in EPSSs: Bridging theory and practice. In C. Montgomerie & J. Viteli (Eds.), *Proceedings of EdMedia World Conference on Educational Multimedia, Hypermedia & Telecommunications* (pp. 658-661). AACE.
- Hannafin, M., Land, S., & Oliver, K. (1999). Open learning environments: Foundations, methods, and models. *Instructional-design Theories And Models: A New Paradigm of Instructional Theory*, 2, 115-140.
- Hanson, J. M., Trolan, T. L., Paulsen, M. B., & Pascarella, E. T. (2016). Evaluating the influence of peer learning on psychological well-being. *Teaching in Higher Education*, 21(2), 191-206.
- Hogan, K. E., & Pressley, M. E. (1997). *Scaffolding student learning: Instructional approaches and issues*. Brookline Books.
- Hsiao, E. (2017). A design case of scaffolding hybrid/online student-centered learning with multimedia. *Journal of Educators Online*, 14(1), n1.
- Huang, K., Chen, C. H., Wu, W. S., & Wei-Yu, C. (2015). Interactivity of question prompts and feedback on secondary students? Science knowledge acquisition and cognitive load. *Journal of Educational Technology & Society*, 18(4), 159.
- Kaoropthai, C., Natakatoong, O., & Cooharajanane, N. (2019). An intelligent diagnostic framework: A scaffolding tool to resolve academic reading problems of Thai first-year university students. *Computers & Education*, 128, 132-144.
- Kim, N. J., Belland, B. R., & Walker. (2018). Effectiveness of computer-based scaffolding in the context of problem-based learning for STEM education: Bayesian meta-analysis. *Educational Psychology Review*, 30(2), 397–429.
- King, A. (1997). ASK to THINK-TEL WHY: A model of transactive peer tutoring for scaffolding higher level complex learning. *Educational psychologist*, 32(4), 221-235.
- Lee, C. Y., Chen, M. J., & Chang, W. L. (2014). Effects of the multiple solutions and question prompts on generalization and justification for non-routine mathematical problem solving in a computer game context. *Eurasia Journal of Mathematics, Science & Technology Education*, 10(2).
- Lee, E., & Hannafin, M. J. (2016). A design framework for enhancing engagement in student-centered learning: Own it, learn it, and share it. *Educational technology research and development*, 64(4), 707-734.
- Lee, J., & Jang, S. (2014). A methodological framework for instructional design model development: Critical dimensions and synthesized procedures. *Educational Technology Research and Development*, 62(6), 743-765.
- Legare, C. H., & Lombrozo, T. (2014). Selective effects of explanation on learning during early childhood. *Journal of experimental child psychology*, 126, 198-212.
- Levine, J. M., & Moreland, R. L. (1991). Culture and socialization in work groups. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition*. American Psychological Association.
- Li, K. M. (2015). Learning styles and perceptions of student teachers of computer-supported collaborative learning strategy using wikis. *Australasian Journal of Educational Technology*, 31(1).
- Lin, S. S. P., & Samuel, M. (2013). Scaffolding during peer response sessions. *Procedia-Social and Behavioral Sciences*, 90, 737-744.
- Loparev, A., & Egert, C. A. (2015). Scaffolding in educational video games: An approach to teaching collaborative support skills. In *2015 IEEE Frontiers in Education Conference (FIE)* (pp. 1-5). IEEE.
- Matthewman, L. J., Nowlan, J., & Hyvönen, K. (2018). Reciprocal peer coaching: A constructivist methodology for enhancing formative assessment strategy in tertiary education. *International Coaching Psychology Review*, 13(1), 35-47.
- Minson, V., Hammer, M., & Veresov, N. N. (2016). Rethinking assessments: creating a new tool using the zone of proximal development within a cultural-historical framework. *Cultural-Historical Psychology*, 12(3), 331-345.
- Morcom, V. E. (2016). Scaffolding peer collaboration through values education: Social and reflective

- practices from a primary classroom. *Australian Journal of Teacher Education*, 41(1), 81-99.
- Morgan, H. (2014). Maximizing student success with differentiated learning. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 87(1), 34-38.
- Nelson, M. M., & Schunn, C. D. (2009). The nature of feedback: How different types of peer feedback affect writing performance. *Instructional Science*, 37(4), 375-401.
- Nordlof, J. (2014). Vygotsky, scaffolding, and the role of theory in writing center work. *The Writing Center Journal*, 34(1), 45-64.
- Obikwelu, C., Read, J., & Sim, G. (2012). The scaffolding mechanism in serious games. *Fun and Game*, 9, 4-6.
- O'Connor, R. E., Notari-Syverson, A., & Vadasy, P. F. (2005). *Ladders to literacy*. Paul H. Brookes Publishing.
- Owensby, J. N., & Kolodner, J. L. (2004). Case application suite: Scaffolding use of expert cases in middle-school project-based inquiry classrooms. In Y. Kafai, W. Sandoval, N. Enyedy, A. Nixon & F. Herrera (Eds.), *Proceedings of the Sixth International Conference of the learning sciences* (pp. 310-317). Lawrence Erlbaum Associates, Inc.
- Pea, R. D. (2004). The social and technological dimensions of scaffolding and related theoretical concepts for learning, education, and human activity. *The Journal of the Learning Sciences*, 13(3), 423-451.
- Pentimonti, J. M., & Justice, L. M. (2010). Teachers' use of scaffolding strategies during read alouds in the preschool classroom. *Early Childhood Education Journal*, 37(4), 241.
- Puntambekar, S. (2009). *Key features of scaffolding*. <http://tcttestreferencematerials.yolasite.com/resources/Scaffolding%20Education.com.pdf>.
- Puntambekar, S. (2015). Distributing scaffolding across multiple levels: Individuals, small groups, and a class of students. *Essential Readings in Problem-Based Learning*, 207-221.
- Puntambekar, S., & Hubscher, R. (2005). Tools for scaffolding learners in a complex learning environment: What have we gained and what have we missed? *Educational Psychologist*, 40(1), 1-12.
- Purnakanishtha, S., Suwannathachote, P., & Nilsook, P. (2014). Development and validation of a problem solving skill test in robot programming using scaffolding tools. *Open Journal of Social Sciences*, 2(02), 47.
- Quaye, S. J., & Harper, S. R. (2015). *Student engagement in higher education: Theoretical perspectives and practical approaches for diverse populations* (2nd ed.). Routledge.
- Rahmani, R., Abbas, M., & Alahyarizadeh, G. (2013). The effects of peer scaffolding in problem-based gaming on the frequency of double-loop learning and performance in integrated science process skills. *Procedia-Social and Behavioral Sciences*, 93, 1994-1999.
- Richey, R. C., & Klein, J. D. (2014). *Design and development research: Methods, strategies, and issues*. Routledge.
- Rogoff, B. (1993). Children's guided participation and participatory appropriation in sociocultural activity. In R. H. Wozniak & K. W. Fischer (Eds.), *Development in context: Acting and thinking in specific environments* (pp. 121-153). Lawrence Erlbaum Associates, Inc.
- Ryu, S., & Lombardi, D. (2015). Coding classroom interactions for collective and individual engagement. *Educational Psychologist*, 50(1), 70-83.
- Sevenhuysen, S., Skinner, E. H., Farlie, M. K., Raitman, L., Nickson, W., Keating, J. L., & Haines, T. P. (2014). Educators and students prefer traditional clinical education to a peer-assisted learning model, despite similar student performance outcomes: a randomised trial. *Journal of Physiotherapy*, 60(4), 209-216.
- Shabani, K. (2016). Applications of Vygotsky's sociocultural approach for teachers' professional development. *Cogent Education*, 3(1), 1252177.
- Smith, P. L., & Ragan, T. J. (1999). *Instructional Design*. Prentice Hall.
- Sottolare, R. A., Graesser, A. C., Hu, X., & Goldberg, B. S. (2014). *Design recommendations for intelligent tutoring systems (Vol. 2: Instructional Management)*. U.S. Army Research Laboratory.
- Stavredes, T. M., & Herder, T. M. (2014). Engaging students in an online environment. *Student engagement in higher education: Theoretical Perspectives and Practical Approaches for Diverse Populations*, 257-270.
- Stone, C. A. (1998). The metaphor of scaffolding: Its utility for the field of learning disabilities. *Journal of Learning Disabilities*, 31(4), 344-364.
- Stone, R., Cooper, S., & Cant, R. (2013). The value of peer learning in undergraduate nursing education: A systematic review. *International Scholarly Research Notices*, 1-10.
- Tan, O. S. (2004). *Enhancing Thinking through problem-based learning approaches*. Thomson.
- ter Beek, M., Opendakker, M. C., Spijkerboer, A. W., Brummer, L., Ozinga, H. W., & Strijbos, J. W. (2019). Scaffolding expository history text reading: Effects on adolescents' comprehension, self-regulation, and motivation. *Learning and Individual Differences*, 74, 101749.
- Thompson, I., & Mackiewicz, J. (2014). Questioning in

- writing center conferences. *The Writing Center Journal*, 37-70.
- Turner, V. D., & Berkowitz, M. W. (2005). Scaffolding morality: Positioning a socio-cultural construct. *New Ideas in Psychology*, 23(3), 174-184.
- Van de Pol, J., Mercer, N., & Volman, M. (2019). Scaffolding student understanding in small-group work: Students' uptake of teacher support in subsequent small-group interaction. *Journal of the Learning Sciences*, 28(2), 206-239.
- Van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher-student interaction: A decade of research. *Educational Psychology Review*, 22(3), 271-296.
- Vrieling, E., Stijnen, S., & Bastiaens, T. (2018). Successful learning: balancing self-regulation with instructional planning. *Teaching in Higher Education*, 23(6), 685-700.
- Vygotsky, L. (1978). *Mind in Society: The Development of Higher Mental Process*. Harvard University Press.
- Waiyakoon, S., Khlaisang, J., & Koraneekij, P. (2015). Development of an instructional learning object design model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students. *Procedia-Social and Behavioral Sciences*, 174, 1489-1496.
- Wang, L. (2007). Sociocultural learning theories and information literacy teaching activities in higher education. *Reference & User Services Quarterly*, 149-158.
- Webb, N. M. (1989). Peer interaction and learning in small groups. *International Journal of Educational Research*, 13(1), 21-39.
- Weng, W. Y., Lin, Y. R., & She, H. C. (2017). Scaffolding for argumentation in hypothetical and theoretical biology concepts. *International Journal of Science Education*, 39(7), 877-897.
- Williams, M., & Burden, R. (2000). *Psychology for language teachers*. Cambridge: Cambridge University Press.
- Wischgoll, A., Pauli, C., & Reusser, K. (2015). Scaffolding—How can contingency lead to successful learning when dealing with errors?. *ZDM*, 47(7), 1147-1159.
- Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, 17(2), 89-100.
- Xie, K., & Bradshaw, A. C. (2008). Using question prompts to support ill-structured problem solving in online peer collaborations. *International Journal of Technology in Teaching and Learning*, 4(2), 148-165.
- Yantraprakorn, P., Darasawang, P., & Wiriyakarun, P. (2013). Enhancing self-efficacy through scaffolding. In *3rd International Conference on Foreign Language Learning and Teaching* (pp. 284-295). LITU.
- Yi, X., Plucker, J. A., & Guo, J. (2015). Modeling influences on divergent thinking and artistic creativity. *Thinking Skills and Creativity*, 16, 62-68.

JEEYOUNG CHUN is an instructional designer in the Office of Research Integrity at the University of Kentucky. She earned her doctoral degree in Instructional Design and Technology from the School of Education at Virginia Polytechnic Institute and State University. Her research interests are interactive learning and peer learning environment design.

KATHERINE CENNAMO is a professor of Instructional Design and Technology in the School of Education at Virginia Polytechnic Institute and State University. Her research interests are application of learning theories to the design and development of instructional products.