Scaffolding

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Scaffolding is an often-used construct to describe the ongoing support provided to a learner by an expert. In this entry, the original notion of scaffolding and its key tenets are discussed, followed by a description of the use of the construct in classrooms and in computer-based systems. The challenges of providing scaffolding to students in a classroom are also discussed.

Scaffolding has been defined by Wood, Bruner, and Ross (1976) as an "adult controlling those elements of the task that are essentially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence." The notion of scaffolding has been linked to the work of Soviet psychologist Lev Vygotsky (1896–1934). However, Vygotsky never used the term *scaffolding* (Stone, 1998), but emphasized the role of social interaction as being crucial to cognitive development, so that learning first occurs at the social or interindividual level. Thus, when a child (or a novice) learns with an adult or a more capable peer, the learning occurs within the child's *zone of proximal development* (ZPD). ZPD is defined as the "distance between the child's actual developmental level as determined by independent problem solving and the higher level of potential development as determined through problem solving under adult guidance and in collaboration with more capable peers" (Vygotksy, 1978, p. 86). Enabling the learner to bridge this gap between the actual and the potential depends on the resources or the kind of support that is provided.

KEY FEATURES OF SCAFFOLDING

The original notion of scaffolding assumed that a single more knowledgeable person, such as a parent or a teacher, helps individual learners, providing them with exactly the support they need to move forward (e.g., Bruner, 1975; Wood et al., 1976). One of the most critical aspects of scaffolding is the role of the adult or the expert. The expert is knowledgeable about the content of instruction as well as a facilitator with the skills, strategies and processes required for teaching. The expert not only helps motivate learners by providing just enough support to enable them to accomplish the goal, but also provides support in the form of modeling, highlighting the critical features of the task, and providing hints and questions that might help learners to reflect (Wood et al., 1976). In this conception then, the adult's role has perceptual and cognitive as well as affective components (Stone, 1998).

Although the role of the adult is crucial, descriptions of the notion of scaffolding (Langer & Applebee, 1986; Palincsar, 1998; Reid, 1998; Stone, 1998) point to several other key elements of scaffolded instruction:

1. *Common goal*. Shared understanding, described as *intersubjectivity* (Rogoff, 1990), is of critical importance in scaffolded instruction. Intersubjectivity refers to the combined ownership of the task between the adult and the child, and setting a common goal.
2. *Ongoing diagnosis and adaptive support*. Perhaps the most important feature of scaffolding is the fact that the adult is constantly evaluating the child's progress and providing support that is appropriate for "*this* tutee, in *this task* at *this* point in task mastering" (Wood et al., 1976, p. 97). This results in interactions that are different in "content and form from individual to individual" (Hogan & Tudge, 1999), and for the same individual at different times. As Wood and colleagues (1976) described, scaffolded interactions comprise of a theory of the task and a theory of the tutee. The adult needs to have a thorough knowledge of the task and its components, the subgoals that need to be accomplished, as well as knowledge of the child's capabilities as they change throughout the instruction.
3. *Dialogues and interactions*. A critical factor in the ongoing diagnosis and calibrated support is the dialogic nature of scaffolding interactions, so that the learner is an active participant and a partner in deciding the direction of the interaction, and not a passive recipient. The dialogic nature of scaffolding is best illustrated in the reciprocal teaching studies of reading (Brown & Palincsar, 1985; Palincsar & Brown, 1984), in which students took turns leading the group discussion, engaging in comprehension monitoring strategies.
4. *Fading and transfer of responsibility*. The final feature of scaffolding is reducing the support provided to learners so that they are in control and take responsibility for their learning. The best scaffolding will eventually lead learners to internalize the processes they are being helped to accomplish (Rogoff, 1990). In the original description by Wood and colleagues (1976), the important aspect of the transfer of responsibility is that the child has not only learned how to complete a specific task, but has also abstracted the process of completing the particular task.

EXAMPLES OF SCAFFOLDING

The early studies that described scaffolding, be they descriptions of parent-child interactions (Greenfield, 1999) or classroom interactions (Langer and Applebee, 1986), were observational rather than interventionist studies. One of the earliest accounts of an interventionist study of scaffolding is Wood, Bruner and Ross's 1976 study in which 3-, 4-, and 5-year-olds engaged in a task of building a pyramid from interlocking blocks, with guidance from a tutor. Each child was tutored individually and the tutor followed a set of guidelines for her tutoring. But the tutor did not always follow pre-set rules in her interactions; instead she provided just enough assistance to help the child move forward—assistance that was sensitive to, and adapted based on, the child's progress. Wood and colleagues documented six types of support that an adult can provide: recruiting the child's interest, reducing the degrees of freedom by simplifying the task, maintaining direction, highlighting the critical task features, controlling frustration, and demonstrating ideal solution paths.

Perhaps the most well-known example of the notion of scaffolding in the classroom is the work on reciprocal teaching (Palinscar & Brown, 1984; Brown & Palinscar, 1985). In this study, groups of students were supported in the process of reading by strategies such as self-directed summarizing (review), questioning, clarifying, and predicting. A teacher or a more capable peer took the lead in modeling the strategies until students in the group could apply them on their own. The teacher or the peer modeled the strategies and used prompts and questions to enable students to apply the four strategies. As described by Palinscar and Brown (1984), the teacher used strategies such as prompting ("What question did you think a teacher might ask?"); instruction ("Remember, a summary is a shortened version, it doesn't include detail"); and modifying the activity ("If you're having a hard time thinking of a question, why don't you summarize first?") (Palinscar & Brown, 1984, p. 131). Both the Wood, Bruner, and Ross study and the reciprocal teaching studies highlight how the key features—intersubjectivity, ongoing diagnosis, tailored assistance, and fading—were attained in the dynamic, interactive environment. Whereas the study by Wood and colleagues illustrates the tutorial interventions in a one-on-one situation, the reciprocal teaching studies were conducted with small groups of learners. In addition, both the quality and the quantity of support were varied, based on the needs of a particular learner. As the learners attained competence, the scaffolding was faded, giving them more control.

SCAFFOLDING IN CLASSROOM SITUATIONS

The notion of scaffolding is increasingly being used to describe the support provided for students to learn successfully in classrooms, especially the use of project- or design-based activities to teach math and science (e.g., Kafai, 1994; Kolodner et al., 2003; Krajcik et al., 1998). Many of these approaches are based on a socioconstruc-tivist model (Vygotsky, 1978; Wertsch, Mcnamee, McLare, & Budwig, 1980) emphasizing that learning occurs in a rich social context, marked by interaction, negotiation, articulation, and collaboration. The original notion of scaffolding, as used in the initial studies of parent-child interactions (Bruner, 1975) or in teacher-student interactions, focused on situations that allowed for one-on-one interactions between the adult or the expert and the learner. The one-on-one nature of the tutoring allowed the adult/teacher to provide "titrated support" (Stone, 1998) that changed based on the progress made by the learner. However, classroom situations involving many students do not allow for the fine-tuned, sensitive, personalized exchange that occurs in one-on-one or small-group scaffolding (Rogoff, 1990). Therefore, instead of one teacher working with each student, support is provided in a paper or software tool that individuals interact with, or classroom activities are redefined so that peers can help each other (e.g., Bell & Davis, 2000; Jackson, Krajcik, & Soloway, 1998; Pun-tambekar & Kolodner, 2002; Reiser et al., 2001).

SOFTWARE TOOLS IN THE CLASSROOM

Software environments that provide support have been developed with the goal of supporting students in the processes that they might find difficult in a complex task when it is not possible for a teacher to attend to each student in a class. Several software tools have been developed to prompt students to reflect, articulate, and complete the steps of a complex task. Examples of such software include ThinkerTools (White & Fredrickson, 1998), Knowledge Integration Environment or KIE (Bell & Davis, 2000), Progress Portfolio (Loh et al., 1998), BGuILE (Reiser et al., 2001) and Model-It (Jackson, Krajcik, & Soloway, 1998).

Quintana and colleagues (2004) have put forth a comprehensive scaffolding design framework for building software tools to help students learn from inquiry-based science activities. Their framework is based on the difficulties that students have during science inquiry and focuses on such aspects of the inquiry process as process management, i.e., the ability to engage in processes and activities required for inquiry; sense making, which they describe as difficulties that learners experience in making sense of their work and finding a direction; and data recording and analysis and articulation.

Reiser (2004) proposed two mechanisms as being essential to software tools that scaffold complex learning: structuring and problematizing. Structuring is believed to scaffold students by decomposing the task and guiding them through the steps of a complex task. Structuring can be provided by using prompts that help students with reflection and articulation, helping them move forward in a complex task. For example, in the software tool Explanation Constructor (Reiser et al., 2001) is an electronic journal that helps students construct their science explanations. In this tool, structuring is provided for articulation and reflection by having students record their research questions, construct explanations, and articulate their findings. In other words, structuring breaks down a complex task into constituent steps to make it more manageable to students. Problematizing, as Reiser described it, “is the flip side of structuring” (p. 287). It involves having learners confront the complexity of the task by helping them focus on aspects of the task that need to be resolved. For example, having students analyze their findings based on a theoretical framework forces students to think about the theoretical constructs that they should use in their explanations, supporting the notion of problematizing.

Software tools and frameworks are based on the difficulties that students have and help students with complex tasks and several strategies that they need. They provide an important first step in the design of scaffolding; however, if the tools do not fade the support, and do not vary the support for different users, they lack the most critical elements of scaffolding, that of ongoing diagnosis and calibrated support.

PEER INTERACTIONS

In addition to software tools, peer interactions have also been considered important for scaffolding in classrooms. In contrast to the adult being the expert in the traditional notion of scaffolding, in peer interactions students support one another through their interactions. Brown and colleagues (1993) emphasized the multidimensional nature of the interactions in a classroom embodying the communities of learners approach. In this environment, the researchers note:

> [learners] of all ages and levels of expertise and interests seed the environment with ideas and knowledge that are appropriated by different learners at different rates, according to their needs and to the current states of the zones of proximal development in which they are engaged.

For example, a modified version of the jigsaw method is used in this approach in which a research theme is divided into subtopics and students in each research group are assigned different topics. Thus every group has a member who is working on a subtopic and every member in a group works on a different subtopic. All the students work on their subtopic and then students come together in reciprocal teaching groups to put their information together and complete the jigsaw. Expertise is therefore distributed amongst all participants, who are engaged in supporting and critiquing one another, justifying views and opinions, and offering suggestions and explanations. The teacher's role changes from that of being a knowledge giver to a facilitator of a community in which students engage in reasoning and justification, eventually helping them to adopt these crucial skills.

DISTRIBUTED SCAFFOLDING

With software tools and peer interactions being used as a way to support learning in classrooms, researchers theorize about a *system* of scaffolding that can describe the complex nature of providing support to multiple students in a classroom. Puntambekar and Kolodner (2005) put forth the notion of *distributed scaffolding* to explain multiple forms of support in the complex environment of a classroom. In this context, support for the design process was provided through the design diaries; in addition, tools such as pin-up sessions and gallery walks were used to help students discuss their designs, providing opportunities for support from teachers and peers. Puntambekar and Kolod-ner (2005) found that multiple forms of support, distributed across available tools, activities, and agents in the classroom, and integrated in ways that admit redundancy, enhance the learning and performance of a wide variety of students in the classroom. In a complex classroom environment, it can be difficult to align all the affordances in such a way that every student can recognize and take advantage of all of them. When support is distributed, integrated, and multiple, there are more chances for students to notice and take advantages of the affordances of the environment and the activity.

Tabak (2004) presents the notion of *synergistic* scaffolds, as a form of distributed scaffolding. According to Tabak, synergy refers to a pattern of scaffolding in which different kinds of support, such as software and teacher coaching, address the learning need but in different ways. Tabak (2004), states that “synergistic scaffolds are different supports that augment each other; they interact and work in concert to guide a single performance of a task or goal” (p. 318). For example, the software could help students reflect while the teacher might model the necessary strategies, so that the software and teacher support together provides students with a complete set of supports to help them successfully complete the task.

With the development of software tools and classrooms interactions as forms of scaffolds, the notion of scaffolding has evolved since its original conception and has changed considerably from the 1990s into the early 21st century. While later approaches have helped researchers understand the kinds of support that are needed to help classroom communities learn successfully, there have also been some aspects of scaffolding that have been difficult to achieve because of the reality of scaffolding in a classroom. Thus, although the notion of scaffolding has evolved, and understanding of providing support in multiple formats has been enriched, it is necessary to think about the critical elements that are missing, such as the ongoing diagnosis of student learning, the careful calibration of support, and fading, the transfer of responsibility to the student.

Current instantiations of the scaffolding construct have addressed a key aspect of scaffolding, i.e., that scaffolding be based on knowledge of the task and the difficulties that students have. However, the tools are permanent and unchanging; they provide structure and consistency by highlighting the aspects of the tasks that students should focus on. While this is by no means trivial, support becomes scaffolding only when it is adaptive, based on an ongoing diagnosis of student learning, and helps students to eventually internalize the knowledge and skills when the scaffolds are removed. More research is needed into how a system of scaffolding can be built, so that ongoing diagnosis and fading can be achieved in classroom situations.

See also:Sociocultural Theory, Vygotsky, Lev Semenovich 1896-1934

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