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Learner Support in Distance and Networked Learning Environments: Ten Dimensions for Successful Design

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ABSTRACT *How do educators and instructional designers assess the effectiveness of the learning environments they design? One important means of ensuring the effectiveness of instruction in distance and face-to-face settings is through provision of learner support. Increasingly, as learners utilize the World Wide Web for collaborative learning, support systems contribute to the processes of learning and assist the learner in developing competencies and confidence in self-regulated learning and social interaction. Originating in the socio-cultural perspective of Vygotskyan theory, the term* scaffolding *refers to learning support based on social constructivist models of learning. As the World Wide Web becomes increasingly integrated into the delivery of learning experiences at primary, tertiary and secondary levels, the concept of scaffolding needs to be reconsidered because it is not readily translated into contexts where the teacher is not present, such as in online learning environments. The aim of this paper is to offer a conceptualization of the term scaffolding in distance learning, to provide examples of how learners can be supported in the processes of constructivist inquiry in a range of learning settings, and to offer principles for the design of learning support that can be applied across a range of instructional settings.*

Why Do We Need Learning Supports?

Educators are the first to admit that not all learners are willing to execute the tasks and activities that lead to successful learning, and that learners need support and structured learning experiences (Collis, 1998; Laurillard, 2002). The recognition that teaching has a supportive dimension has long been recognized (Biggs, 1999). *Scaffolding* is the term widely used to describe effective learning support with an interesting history. Wood, Bruner and Ross (1976) originally coined the term scaffolding as a metaphor to describe the effective intervention by a peer, adult or competent person in the learning of another person. The term can be traced to Vygotsky's concept of the zone of proximal development, which refers to a learner's optimal developmental potential, if assistance that is timely and appropriate is provided by another person (Vygotsky, 1978). The appeal of the concept of scaffolding lies in the fact that it directs attention to the need for support in the learning process, and does so in a way that emphasizes that good teaching is necessarily responsive to the state of understanding achieved by particular learners.

In distance learning settings, the metaphor of scaffolding is appealing in principle, yet elusive and problematic. With reference to distance learning, Garrison and Baynton (1987)

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TABLE 1. Design guidelines for constructivist learning

• Provide experience of the knowledge construction process • Provide experience in and appreciation of multiple perspectives • Create learning tasks that are relevant and authentic • Encourage ownership and voice in the learning process • Embed learning in social experience • Encourage the development of multiple modes of representation • Encourage self-awareness of the knowledge construction process

propose that the learner support system includes the resources that the learner can access in order to engage in the learning process (learning materials, library, teacher/facilitator), and resources, which relate to the mediation of the communication process (media and technology). While correspondence education relied on detailed comments written by a tutor, open and distance learning has diverged by using a range of media and by introducing the notion of small group dialogue and interaction with learners.

Research on student learning has had profound and far-reaching influences on how current practitioners design learning environments and on how they conceptualize learner support systems (e.g., Inglis, Ling & Joosten, 1999; Jarvela, 1995; Roschelle & Teasley, 1995). Examples of the issues surrounding transfer of learning support to online settings can be seen in the published policies of many universities (Brigham, 2001; Sparks, 1996). The aim of this article is to demonstrate that the core principles of effective scaffolding do not differ from the original Vygotskyan conceptualization of optimum cognitive development through assistance, but the role of ICT and online environments has created a need to rethink issues of agency, and the respective roles of peers, facilitators and teachers in offering learning support. In addition, the social, collaborative and communicative aspects of online learning have created new possibilities for redesigning learning support systems (McLachlan-Smith & Gunn, 2001; McLoughlin & Oliver, 1998b).

Traditional Scaffolding in Practice

If we assume that constructivist learning involves students in goal-directed, intentional knowledge building, then it is possible to identify instructional design guidelines that enable the creation of effective environments that support learning. According to Oliver and McLoughlin (2001) the principles underpinning constructivist learning can be summarized as shown in Table 1. That is, in order to support learning, the task, teacher and environment must provide certain conditions for learning.

An explanation of scaffolding, or support for learning in the practise of face-to-face teaching is given by Tharp and Gallimore (1988) and other authors. Levels of support may vary in form, substance and complexity depending on the context. Support may take the form of a teacher modelling the target performance of a task, or giving verbal explanations that identify the elements of the task and strategy. In a similar vein, Beed, Hawkins and Roller (1991) have described forms of support as follows:

- *Assisted modelling*: Teachers provide some coaching and models that enable the completion of the task.
- *Element identification*: The teacher identifies the elements of the desired approach or strategies to help students complete the task.
- *Strategy naming*: The teacher articulates a relevant strategy and students employ it on their own.

Roehler and Cantlon (1997) focus on the types and characteristics of scaffolding in learning conversations in face-to-face settings and several different types are identified:

- *Offering explanations*: Explicit statements are given by an expert to elaborate on learners' emerging understandings.
- *Inviting students' participation*: Learners are given opportunities to assume control of the knowledge-building process.
- *Verification and clarification of students' understandings*: If emerging understandings are reasonable, the teacher verifies the students' responses. If the understandings are erroneous, the teacher offers clarification.
- *Modelling of desired behaviours*: This includes making thinking visible, as in think-aloud, showing what someone thinks about the learning process at a given moment.
- *Generating questions and comments as in think-aloud*: This occurs, for example, when a teacher shows how to articulate a problem-solving process by talking through the steps. Teachers generate questions and comments initially and students then take over the questioning role.
- *Inviting students to contribute actively*: Learners are encouraged to contribute clues in order to complete a task and to articulate their understandings of task demands.

As technology extends learning beyond the classroom to learning communities, so must roles and concepts of learning and teaching be reconsidered (Brown & Campione, 1994; Collis, Winnips & Moonen, 2000). While research conducted in face-to-face settings forms the initial groundwork on scaffolding as the conceptual basis for learning support, a great deal of research in distance education has confirmed that many dimensions of the original conceptualization by Wood *et al.* (1976) are still relevant in contexts mediated by technology. For example, effective e-moderation utilizes many of the strategies listed above (Salmon, 2001).

Scaffolding in Distance Learning and Online Settings

Some similarities and differences emerge when we compare recent work on learner support with earlier research on scaffolding conducted in the 1980s. A major difference is that earlier work was conducted in face-to-face classrooms, where forms of verbal interaction were the most common forms of scaffolding (Palincsar, 1986; Rosenshine & Meister 1992; Tharp, 1993). Teachers and learners occupied the same space, and engaged in learning processes in the social context of a conventional classroom, with its prescribed rules, roles and expectations. This often limited scaffolding to teacher-initiated discourse. For example, in many traditional classrooms, teacher questioning has been shown to be a form of task structuring and a means of supporting learning (Edwards & Westgate, 1994). If we consider face-to-face teaching in comparison with distance learning, which is primarily resource based and

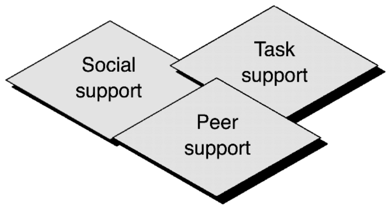

FIG. 1. Key elements of learning support in a distance learning setting.

self-paced, direct intervention and support by a teacher is not always possible, for example in virtual classrooms or in contexts where learning is asynchronous and self-paced.

In addition, the nature of scaffolding in face-to-face classrooms was assumed to be asymmetric in that the teacher was regarded as the expert, and the student was the novice (Tharp, 1993). Recent advances in communications technologies and in pedagogy envisage an active, participatory role for students, as initiators and co-participants in self-regulating learning processes (Collis & Moonen, 2001). As technology becomes increasingly integrated into the delivery of learning experiences at primary, tertiary and secondary levels, the concept of scaffolding needs to be extended. This calls for a reconsideration of the nature of learner support and for the alignment of the original theory with current teaching and learning practices.

McLoughlin and Oliver (1998a) discuss the forms of scaffolding that are required to foster higher order thinking in distance education settings mediated by technology. Effective support would need to include the encouragement of reflective thinking, provision of social support for dialogue, interaction and extension of ideas with feedback from peers and mentors on emerging issues. These support features are depicted in Fig. 1 and they represent core elements of support for the learning process in environments mediated by technology. While the principles underpinning support for learning may not vary according to context, the agency of the teacher in online and face-to-face contexts is different from face-to-face settings, and the diagram depicts three aspects of support, which can be provided by peers and by online functionalities, without requiring direct teacher intervention.

For example, in learning from the World Wide Web, distributed groups of learners can be assisted in the learning process by different technological functionalities which enable dialogue, reflection and interaction, thus affording opportunities for social support and the creation of an online community. Similarly, peer support that is provided through discussion forums allows sharing of information, review of ideas and feedback among groups of learners (McConnell, 2000). Collaborative work can be supported by developing World Wide Web tools to support or scaffold group processes and cognition, for example by providing virtual workspaces, document exchanges and databases for student work. Collis and Moonen (2001) have "re-engineered" academic courses and developed a number of cognitive tools to enable group work and to provide various forms of assistance and guidance for learners.

A number of scaffolding solutions using information and communications technology (ICT) tools to enable cognitive outcomes that underpin successful learning are categorized and examples are provided based on the work of Collis *et al.* (2000), Winnips (2000) and Oliver and McLoughlin (2001). Table 2 describes the different forms of support and associated learner interactions which range from information access, through collaborative inquiry

TABLE 2. Categories of scaffolding across different teaching contexts

Scaffold	Description
• Orientation: communication of expectation	Students are provided with a clear description of what they should achieve, and what the target performance is, e.g., through a Web page or printed guide
• Coaching	The learner receives support via software to help performance of a task, e.g., presentation and demonstration are contextualized via computer application (e.g., audio file)
• Eliciting articulation	Articulation is encouraged in order to express current understanding and reflection, e.g., peer communication via a bulletin board on procedures for problem solving
• Task support	Support structures are created so that the learner is able to perform the task, e.g., through provision of heuristics or resources that enable task engagement and activity
• Expert regulation	Support is based on provision of expertise by an expert or mentor, showing examples and desired learning outcomes
• Conceptual scaffolding	Help is provided when the problem or task is presented so as to focus the learner towards problem definition where there may be multiple interpretations. This may be achieved through the presentation of parallel scenarios and problems that enable the learner to practise analytic skills
• Metacognitive scaffolding	Metacognitive scaffolding can be provided by a cognitive tool (e.g., an electronic notepad) to enable students to record their thinking while engaging with an actual problem. This supports the underlying processes associated with learning management and reflection
• Procedural scaffolding	Procedural scaffolding supports learners in using available tools and resources. In Web-based teaching, this may be in the form of access to databases, support for collaborative learning and resource sharing
• Strategic scaffolding	Strategic scaffolding is afforded by emphasizing alternative courses of action and learning pathways that might be applied in classroom contexts. The presentation of multiple scenarios, events and perspectives enables students to engage in planning and decision making

strategies to networked forms of communication (Wild, 1999; Winnips, 2000; Winnips & McLoughlin, 2001).

These forms of scaffolding may be offered online and in distance settings by a facilitator and/or a range of technologies, while in a face-to-face context teacher intervention would be essential. Nevertheless, consideration of other recent work in technology-supported environments illustrates how the concept of scaffolding has expanded to include many alternative forms of support, increased responsibility for students and a reduction in the direct intervention of the teacher that characterized earlier work on scaffolding.

A Range of Technological Approaches to Enable Scaffolded Learning

While Vygotskyan theory provides the theoretical anchoring needed by making an explicit connection between social interaction and cognitive development, other forms of support can be provided by technology, thus enabling learners to engage in cognitive change and skills advancement. Apart from utilizing the functionalities of the World Wide Web to support learning, recent research in technology-mediated environments presents an array of possibilities and perspectives on scaffolding. By investigating these applications it is possible to compare and extrapolate common features and propose principles for future research. The following four examples of scaffolded instruction using hypermedia provide contrasting scenarios for recent interpretations of assisted instruction. What is notable about these is the agency of technology, and the absence of direct teacher intervention.

Computer-Supported Intentional Learning Environments (CSILEs)

This approach, conceived by Scardamalia and Bereiter (Scardamalia and Bereiter, 1992, 1994; Scardamalia, Bereiter, McLean & Woodruff, 1989) provides a powerful collaborative medium based on anchored design and discourse space, in which students can negotiate and construct new understandings. In the environment, the teacher's role is transformed from that of manager to facilitator of student collaborative processes. A CSILE is an experimental computer system which can mediate shared spaces for collaborative knowledge building. The basis for this is a shared communal database, which gives students a common space to create and communicate ideas and representations that emerge from individual and group work. In addition to supporting social interactions needed for shared understanding, it provides the resources required for reaching reciprocal understanding, and facilities for the shared product to be expanded, altered, clarified, elaborated and manipulated for new meanings to emerge. A shared database of text and graphics notes allows learners to access and collaborate on the creation of knowledge objects. CSILEs have inspired further work and have provided a supportive medium for a number of projects (Cognition and Technology Group at Vanderbilt, 1993, 1996).

Intelligent Tutoring Systems (ITSs)

In an intelligent tutoring system, learners are guided through learning processes and provided with structures and sequences of tasks to assist them. Well-known examples can be seen in the work of Anderson, Boyle, Corbett and Lewis (1990) where students are taught to solve algebra word problems, develop programs and generate geometry proofs. By reducing the complexity of the task and providing cognitive structuring, an ITS can scaffold learning. In an intelligent tutoring system, a learner's progress is charted against an expert model of the process, which the student is expected to model. Intelligent tutoring systems have been criticized for lack of authenticity in the learning environment, and for creating tasks where students do not have to engage in real-life problem solving (Guzdial & Kehoe, 1998). In ITS environments, collaboration in learning is less essential than in other apprenticeship settings.

Goal-Based Scenarios (GBSs)

Goal-based scenarios are learning settings in which students have to engage in an authentic task where they are presented with a goal to achieve. The objective is for students to acquire and develop the requisite process skills and conceptual knowledge to attain the goal (Schank, 1992; Schank, Fano, Bell & Jona, 1994). Students are provided with technology-based resources to achieve these goals, and their performance is compared to that of successful models of the process. If a learner cannot achieve the goal, scaffolding is provided in the form of process information, which gives corrective feedback in story form to help the learner address the problem. In a GBS, students interact with agents embedded in the system, rather than with socially based collaborators or peers. GBSs are nevertheless unable to provide feedback or support for complex abstract processes where there is no single solution (Schank, Berman & McPherson, 1999).

Design Support Environments (DSEs)

Design support environments are aimed at supporting learning through a form of software-realized scaffolding tailored to assist students to engage in the design of software or instruction. In DSEs the environment is simplified by providing a large number of cases, coaching students in the design process and reducing support when performance improves (Hmelo & Day, 1999). Instead of providing students with assistance in problem solving, they simply scaffold the design process. A further feature of some DSEs is that they provide adaptive scaffolds, where students can choose to turn off supports that are not required, thereby increasing their independence.

Effective Scaffolding: Summarizing the Literature

Examples of a range of technology-based scaffolds can be found in the literature cited and each offers a unique perspective on assisted forms of learning, comparable with the Vygotskyan conception of apprenticeship learning proposed by Collins, Brown and Newman (1989). While each form of scaffolding provides learning support, each may differ in the degree and nature of assistance offered for social engagement, peer learning and task structuring. In face-to-face settings the teacher plays a direct interventionist role, while in distance settings scaffolds can be created by software, technological tools and Web-based functionalities. Nevertheless, there remains agreement that the principles of scaffolding that support learning can be identified and that these principles apply across face-to-face and distance education settings (Hmelo & Day, 1999; Oliver & McLoughlin, 2001; Winnips, 2000). Effective scaffolding is characterized by:

- reducing the scope for failure in the task that the learner is attempting;
- enabling learners to accomplish a task that they would not be able to achieve on their own;
- moving learners to a new and improved zone of understanding;
- bringing learners closer to a state of independent competence.

On this basis, and having reviewed present and past developments in scaffolding, it is possible to propose guidelines that can be applied to the design of effective learning support.

Design of Scaffolds: Dimensions That Support Both Process and Product Outcomes

If the result of successful scaffolding is independent performance, and movement by the learner into a new zone of development, it should be possible to systematize the design of scaffolds and develop principles that can be applied across a range of learning environments. Through the application of constructivist principles drawn from a range of contexts where technology is used to foster self-regulated learning, and by extrapolating the principles of learning support underpinning these designs, a set of dimensions is proposed to enable the design of learning support (Oliver & McLoughlin, 2001; Winnips & McLoughlin, 2001).

The design guidelines proposed take the form of 10 dimensions of successful learner support, similar to Reeves and Reeves' (1997) notion that learning online can be evaluated according to a number of principles. Each dimension is represented as a continuum with contrasting values at each end. The individual dimensions need to be aggregated in order to create effective instructional scaffolds.

(1) Goal orientation

Goal orientation

highly focused ⟷ unfocused

The goal for the support can range from highly focused to unfocused or non-specific. For scaffolding to succeed, it must be planned and designed to achieve independent learning and task performance. For example, it is not enough to help students when they are in difficulty. The level and amount of support should be goal directed so that learners know how and when it can be applied, so that they receive help to achieve a particular learning goal. For example, helping students to find resources on the Web to complete as assignment equips them with a focused form of support that enables task completion while fostering independent learning.

(2) Adaptability

Adaptability

fixed ⟷ flexible

This dimension refers to the flexibility of the scaffold to meet the needs of a diverse range of students. Optimally, support should be capable of modification by students and be "faded" or reduced as learner competence grows. Scaffolds are intended to work within the learners' zones of development so that improvement beyond the current level of competence is facilitated. Effective scaffolding diminishes when students achieve a greater degree of competence. Scaffolding must be flexible enough to engage the learner at his/her present level of understanding and to diminish once improved performance is achieved. An example may be the use of an online chat tool to support socialization of learners new to online learning, with the tool being adaptable to group size, learning styles, pedagogy and task.

(3) Accessibility

Accessibility

high ⟷ low

The scaffold needs to be accessible to students when they need it, in the form of "just-in-time" support. In face-to-face classrooms, teachers can monitor the situation and intervene to coach or model a process when needed, but in Web-based settings, tutorial supports can provide this form of assistance. For example, an online frequently asked question tool or FAQ (with input from a moderator according to need) can be made accessible to all learners in a course of study, which may help to develop self-directed learning.

(4) Alignment

Alignment

high ⟷ low

This means that the support should be aligned with task goals and learning outcomes so that the learning experience is a seamless one for the student. Aligning scaffolds with task and assessment design ensures consistency and structure in course design (see Biggs, 1999). For example, if collaborative learning is the desired outcome, a scaffold such as a collaborative workspace that enables multiple perspective and sharing of ideas would be appropriate.

(5) Experiential value

Experiential value

high ⟷ low

To foster effective learning, it is important to make sure that the learners are not just exposed to inert facts and information but that that they are afforded an experience that enables them to plan, act and reflect. Scaffolds should enable transfer of skill to a novel task and provide concerted support for learning. For example, the Cognition and Technology Group at Vanderbilt (1996) have created a focal event or situation as an "anchor" or focus for learning, and their research indicates that these concrete supports help students to create new knowledge.

(6) Collaboration

Collaboration

supported ⟷ unsupported

Learning though social dialogue and collaboration has been a feature of much of educational research more recently. Many argue that one of the strengths of technology is that it supports collaboration and dialogue (McConnell, 2000). Recent emphasis on social constructivism, and use of the Web as a tool to scaffold collaboration and create shared public representation of knowledge indicates that this dimension of scaffolding is already well accepted.

(7) Constructivism

Constructivism

strong $\longleftrightarrow$ weak

The scaffolding activity should be designed to support knowledge construction (strong scaffold), not memorization or rote learning (weak scaffold). For example, cognitive apprenticeship theory has drawn attention to scaffolding, with an emphasis on modelling expert performance, with students articulating their understandings and gradually approximating expert performance (Collins *et al.*, 1989). Technology-based scaffolding supports knowledge construction by representing learners' ideas, beliefs and understandings, and by offering tools for accessing needed information so that learners can create new knowledge. Provision of hyperlinked resources linked to a learning task may be used to support exploration and promote resource selection and synthesis of information.

(8) Learning orientation

Learning orientation

teacher regulation $\longleftrightarrow$ learner regulation

As successful learning is a purposeful activity engaged in by learners, the role of the teacher is to foster independent learning and self-regulation. If competence is the desired level of achievement, then scaffolds must be designed to ensure that the learner progresses from teacher regulation to self-regulation and learner self-direction. Effective scaffolds are not intended to increase teacher intervention or supplant learner-generated activity but to encourage self-regulation and reflection by learners on their own processes and actions.

(9) Multiplicity

Multiplicity

one-dimensional $\longleftrightarrow$ multi-dimensional

Scaffolds must be designed to support many facets of the learning activity. Researchers have suggested various forms of scaffolding (see Table 1), which are intended to support key aspects of the learning process such as metacognition, reflection, articulation and comparison of multiple perspectives. The multiplicity continuum proposes that scaffolds can range from one-dimensional (limited to one aspect of learning) to multi-dimensional (applicable to many aspects of learning). For example, threaded computer conferencing may provide support for collaborative problem solving, with articulation and elaboration of views, thereby providing multiple forms of support.

(10) Granularity

Granularity

low granularity ⟷ high granularity

The EDUCAUSE Instructional Management System (IMS) uses the term "relative size of a resource" as their working definition of granularity. The relative size of instructional resources ranges from low to high granularity as follows: curriculum, course, unit, topic, and lesson fragment (Wiley, South, Bassett, Nelson, Seawright, Peterson & Monson, 1999). A large resource has low granularity. In learning and teaching, high granularity is a property of resources and strategies as tasks need to be broken down into component parts or deconstructed. High granularity in scaffolding enables learners to select and reconstruct the parts that are meaningful to them within a task and are therefore more efficient. Scaffolds therefore need to be created at the level of task and fragment, as the micro-level of task engagement is critical to learning.

Conclusions

Instructional designers and teachers in higher education need to ensure quality learning support for students as learning environments are increasingly designed according to the principles of resource-based and independent learning. A great deal of research has indicated that learners need to be given more control over their learning environment and the activities they undertake. Nevertheless, in some cases, online environments may take for granted the skills of learners and overlook their need to have a repertoire of learning strategies.

Designing scaffolds for learning involves conceptualizing new roles for learners and teachers in fostering task engagement, social interaction and peer feedback. In a sustainable learning environment, support must be designed in a principled way in order to ensure that learners progress from teacher-directed activity to self-regulated activity. The principles of scaffolding discussed here are based upon research in self-regulated learning, socio-cultural and constructivist learning theory and learner-centred psychological principles.

The article proposes that the term scaffolding offers a conceptual framework for effective learning support as it provides a clear definition of the characteristics of learning support. Three core aspects of scaffolding applicable to distance and online learning are identified as task and peer support and support for social interaction, while the agency of the teacher/facilitator in offering this support will differ, depending on the context. In addition, examples of categories of scaffolding are summarized from existing research and may be applied across a range of learning contexts (see Table 2). The proposed 10 design dimensions are based on ingredients of effective scaffolding identified from the literature and from current empirical research in the field. These design dimensions can also be applied to determine the value of the scaffold and the likelihood that it will support constructive learning. The dimensions are intended to serve as a set of benchmarks based on constructivist principles which guide the design of instructional scaffolds. As yet, research on the nature of effective scaffolding is limited, as it is likely that these dimensions will be further refined through application and evaluation in specific learning contexts.

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