

Cognitive Tools in Web-based Learning Environments: Implications for Design and Practice

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Abstract

Cognitive tools are well documented in multimedia learning environments but there has been limited transfer to online learning environments, particularly to Web-based Learning Management Systems (LMS). This paper describes specific tools appropriate for LMS and advocates purposeful integration of cognitive tools in support of adaptive learning for diverse populations.

Industry, government, and higher education have been pressed to offer training that meets the needs of the 21st century worker and student offering flexible scheduling and self-paced courses (Woods & Cortada, 2002; Fjortoft, 1995) at reasonable costs (Aldrich, 2001). Some experts believe that conventional education and training are obsolete in view of increasingly sophisticated and readily available learning management systems (LMS) (Delphi Group, 20002. Because the Web-based learner is physically isolated from peers and typically learns autonomously he or she may or may not be prepared to construct effective learning supports. Therefore the integration of tools that support learning are most critical, even more so when the instructor is not present to determine learner's progress or understanding. This paper briefly discusses cognitive supports as they relate to the nature of Web-based Learning Environments (WBLEs).

Conceptualizing Cognitive Tools

Web-based Learning Environments (WBLEs) typically require that the learner work autonomously and independently. Feedback mechanisms are mostly user-generated rather than technology-generated and yet there are many instances in which WBLEs have provided mechanisms that support the learner in a variety of ways: with study strategies (Morgan, Dingsdag, & Saenger, 1998), prior knowledge evaluation (Portier & Wagemans, 1995), resources for information retrieval and problem solving (Oliver, 1999), tutorials, and advising services (Wright, 1991). These supports are primarily cognitive, supporting the mental functions required of the online learner.

The term cognitive tool has been defined in several ways. Jonassen (1994) states that computers and the software that provides interactivity are cognitive tools that allow the learner to use them "as tools for knowledge construction rather than media of conveyance and knowledge acquisition" (p.2) as learners are actively involved in constructing their own knowledge and learning *with* technology (Jonassen, 1991). Others define cognitive tools by the function served within an electronic learning environment (Lajoie, 1993). This approach is not in conflict with Jonassen's general notion but more specifically identifies cognitive devices which support learning strategies that vary by learning context. Such tools may support cognitive processes, reduce cognitive load of the learner, extend the cognitive capabilities of the learner or allow the learner to test ideas within problem solving contexts (Lajoie, 1993). Katz (1997) suggests that cognitive tools should support processes of learning that are associated with study strategies such as review, rehearsal, attention, practice, and application. Regardless of how cognitive tools is conceptualized, learning at a distance is essentially learner centered and as such requires supports that are responsive to the learner's immediate needs (Thompson, 1998).

Sugrue (2000) identifies four aspects of learning environments that require cognitive strategies that could be supported by tools, only one of which can be reasonably applied to learner-only interaction, Information Organization and Access¹. Helping the learner navigate and interact with the electronic environment supports Lajoie's (1993) idea that cognitive tools can reduce cognitive load and assist with lower level thinking processes so that the learner may engage in higher order thinking. Many cognitive tools identified and used in interactive multimedia learning environments resemble devices found in print materials that assist in identifying location within

¹ The other strategies require opportunities to interact with others: Authentic Activities, Collaborative Learning, and Student Modeling.

a system or finding one's place, such as bookmarks (Katz, 2001). Erickson and Lehrer (2000) suggest that hyperlinks serve as cognitive tools if they are used intentionally and for specific purposes such as for navigation functions, offering elaborative information, or for structural organization. Index or navigational interface windows (Jonassen, 1998) provide the user with information about their location and/or progress, possibly through a program or site map.

Other tools assist the learner in locating information such as find, glossary (Katz, 2001; Sinita, Mizoguchi, & Serdjuk, 2001), and help functions which may also provide cues, elaboration or explanations (Katz, 2001). Tags, pop-up graphics, or rollovers may also direct the user to useful or clarifying information. It may be that visual cues such as wipes and dissolves direct the user's attention and support the perceived coherency of the material presented (Slatin, 1991). Additionally, explanatory interface windows (Jonassen, 1989) may elucidate, give details, or coach the user. Others have identified cognitive tools that may serve as an organizer of knowledge or illustrate the relationship of parts to the whole illustrating how knowledge is represented in memory (Sugrue, 2000). Concept and knowledge maps can help learners see the big picture of the relationship of concepts within a specific structure more clear (Rewey, Dansereau, Skaggs, Hall, & Pitre, 1989), making connections between prior and future learning. Metaphorical interface windows provide a representation of material designed to link prior knowledge to materials being learned and organization interface windows support the user's process of making sense out of information (Jonassen, 1998). Devices that allow the user to record and organize information are also described as cognitive tools. Harper, Hedberg, Coderoy, and Wright (2000) suggest that authoring tools are a means for students to present ideas for examination by others. Not all learners work well with 2-dimensional electronic representations so notepad (Katz, 2001) or downloadable documents may also function as a cognitive tool if they are used to store ideas and thoughts that are referenced in the process of learning.

Implications and Further Studies

It may be that the nature of Learning Management Systems (LMS) is grounded in the notion of knowledge *management* as opposed to knowledge *construction*. Activating the learner's schema is less likely in a prescribed and pre-determined WBLE, however, adaptive cognitive tools may allow the learner to construct understanding by facilitating the learner's organization of information (Woolf, 1992) which can then be substantiated through interaction with other learners and the course instructor (Derry, 1992; Jones, Greer, Mandicah, du Boulay, & Goodyear, 1992). If a learner enters a WBLE and is offered a path that appropriately supports his or her entry level skills, technology or content knowledge, or learning orientation, the cognitive load will be diminished and embedded supports will facilitate understanding and more authentically respond to the unique and individual needs of the learner (Laurillard, 1992). This is the intent of cognitive tools, particularly in systems which presuppose or require the learner to work to some degree without interacting with others.

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