Cognitive Load Theory of Learning: Underpinnings and Model

Jim F. Schilling, PhD, ATC, CSCS • University of Southern Maine

To apply effective instructional strategies, educators need to understand how students learn. Most learning theories fall under three general philosophies including behaviorism, constructivism, and cognitivism. The behaviorism learning theory is stimulus-response-based. It emphasizes repetition and reinforcement to develop desired behaviors which become habit. For example, consistent positive feedback to students when sharing correct answers to questions or skill demonstrations provides a positive stimulus to encourage learning. Unfortunately, there is a lack of evidence to support behaviorism as an explanation of how people learn.

Constructivism suggests learning requires the student to actively construct knowledge within a particular context. Examples of constructivism are found in a number of discovery learning theories. Experiential learning is an offshoot of constructivism where learning is a process of acquiring knowledge and skills via the experience of doing particular activities. There is evidence of significantly improved occupational therapy-related skills, critical thinking, and clinical reasoning with experiential learning. Kolb and Kolb have also argued that individual students have unique learning styles which require tailored instructional strategies for effective learning. For example, some students may prefer observing a particular skill and the reflecting, others may require reading and analyzing information explaining a skill, and yet others may choose applying the skill in a clinical setting through simulation or real-life situations. Unfortunately, learning-styles-based instruction lacks evidence to support its application. Another descendent of constructivism is active learning, which requires students to be engaged or active in the learning process. There are a number of instructional strategies to encourage an active learning environment such as collaborative, cooperative, and problem-based learning. With collaborative learning, a group of students work together and are assessed together on the same project which provides an emphasis on student interaction. Cooperative learning also provides a group learning experience, however each student has a specific assignment which is assessed separately. Implementation of the sociocultural learning theory, which supports collaborative and cooperative learning, was suggested for athletic training programs to promote an environment that encourages social interactions. Examples of sociocultural application in athletic training would
be clinical education, technology, and research. There is evidence that demonstrates improved competence with the employment of cooperative\textsuperscript{9} and collaborative\textsuperscript{10} learning with pharmacy and physical therapy students respectively.

Another active learning strategy called problem-based learning is conducted by an individual or groups of students that are given scenarios or problems which require analysis to understand and resolve.\textsuperscript{7} Athletic training students and educators perceive the use of scenarios and administering authentic experiences, along with providing a positive educational environment, as effective learning strategies.\textsuperscript{11} Athletic training has made a strong recommendation for educators to use techniques which engage critical thinking.\textsuperscript{12} Critical thinking is considered a process where the learner evaluates, analyzes, and interprets information.\textsuperscript{13} Problem-based learning is a common technique used to promote critical thinking.\textsuperscript{14} Evidence inquiring the effectiveness of problem-based learning enhancing critical thinking with nursing students was not supported.\textsuperscript{15} In addition, a study using human physiology students who were asked to present material and questioned on their reasoning, along with the application of in-class problem-solving activities, found their learning was not greater than traditional strategies.\textsuperscript{16} A review of controlled trials in disciplines such as physiotherapy, occupational therapy, dietetics, and therapeutic radiology was also conducted and found no significant advantage with problem-based learning over didactic approaches in learning knowledge and performance skills.\textsuperscript{17} Student interaction strategies as forms of active learning have demonstrated benefits in learning, however problem-based techniques have lacked support.

Experts in the area of cognitive psychology argue that strategies such as problem-based learning to encourage critical thinking with students who have an insufficient subject matter knowledge base or inappropriate instructional guidance could actually cause learning inhibition.\textsuperscript{18} The complexity of material and timing of its delivery are factors in learning. To develop effective instructional strategies that encourage optimal learning, understanding how information is stored in memory is critical. An explanation is provided by the cognitive load theory (CLT), which falls under the educational philosophy of cognitivism. There is evidence to support this theory and how appropriate instructional guidance enables optimal storage of information and greater learning outcomes than traditional techniques.\textsuperscript{19,20} In these studies, learning outcomes were enhanced by using worked examples\textsuperscript{19} and modeling.\textsuperscript{20} For example, a technique would be presenting the students with a specific injury to assess and explaining the entire examination process as a worked example or demonstrating the process using a human or simulated model. With evidence\textsuperscript{19,20} supporting instructional strategies consistent with the CLT, it would be advantageous for educators in athletic training programs to apply these techniques for effective and efficient student learning. The purpose of this article is to introduce the CLT of learning model by first establishing its underpinnings, followed by an explanation of its architectural framework and operation.

### Cognitive Load Theory Underpinnings

The underpinnings for the CLT of learning were developed from evidence of pattern recognition and schema development from experimentation done in the 1930s and 1940s. The results from deGroot’s work in 1946 suggest that elite chess players have the ability to recognize patterns based on previous experience.\textsuperscript{21} A similar study by Connors et al.,\textsuperscript{22} also using chess players, confirmed de Groot’s findings. The ability of expert chess players to recall strategic situations quickly and accurately was explained by having chunks of information or schemas stored in their long-term memory. Evidence of schema formation was first introduced by Bartlett in the early 1930s, which suggested learners disregarded unusual descriptions of events when presented new material.\textsuperscript{23} Instead, when asked to recall the new information, they remembered schematic representations of familiar events.\textsuperscript{23} Although there does not seem to be a clear and consistent definition for the concept schema,\textsuperscript{24} it was described as a recognition device of organized structures.\textsuperscript{25} These schema, or packets of information, require an active process to construct and store in long-term memory.\textsuperscript{26} This research describes the mind’s ability to store schemas and provides an explanation of how we store and recall chunks of information from long-term memory.

### Cognitive Load Theory Model

In the early 1980s, Sweller\textsuperscript{27} proposed a human cognitive architecture model as a visual explanation of the mind’s ability to store information. This model was the groundwork for the CLT of learning. The basic architecture of the CLT is composed of two systems: (1) working