

Preventing Information Overload: Cognitive Load Theory as an Instructional Framework for Teaching Pharmacology

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ABSTRACT

Nursing students are challenged by content-laden curricula and learning environments that emphasize testing outcomes. Likewise, educators are challenged to support student-centered learning in a manner that encourages students to connect and act upon their personal motivations. This article describes the use of cognitive load theory (CLT) as an instructional design framework for an undergraduate pharmacology for nursing course. Guided by the principles of CLT, four instructional strategies were used in this course: (a) opening review activities, (b) providing students with lecture notes, (c) a "Top Five" prototype approach, and (d) deciphering "Need to Knows" from "Nice to Knows." Instructional style and strategies received positive student feedback and were found to promote a student-centered environment and active learning. On the basis of this feedback, cognitive load theory may be a successful and effective framework for undergraduate pharmacology and other nursing courses, thus assisting students and educators alike in overcoming obstacles imposed on learning environments. [*J Nurs Educ.* 2014;53(2):108-111.]

The learning environment within nursing education has evolved significantly over the years, with increasingly accessible forms of technology serving as the catalyst. Students today are surrounded by countless communication and information channels, and each medium encourages the exploration and discovery of answers to their many questions. Due in part to these technological advances, the educational philosophy in nursing has shifted away from the traditional focus on behavioral outcomes to one that supports flexible, collaborative, evidence-based curricula designed to expand beyond linear thinking and integrate current technology (National League for Nursing, 2003; Stanley & Dougherty, 2010).

Many students enter the nursing profession inspired by the desire to help people. Unfortunately, many of these same students also quickly feel bogged down by heavy, content-laden curricula or learning environments that emphasize exit examination scores or NCLEX-RN® pass rates. Thus, educators are challenged to support student-centered learning and develop methods for motivating and encouraging students to connect with and act upon their personal motivations, while still recognizing the unique complexities and challenges that students face in nursing school. When used as an instructional framework, cognitive load theory (CLT) may assist nurse educators in overcoming these challenges. The purpose of this article is to describe the principles of CLT and how it can be used as a framework for the instructional design of an undergraduate pharmacology course for nursing students.

Cognitive Load Theory

Educational psychologist John Sweller developed the CLT in response to research demonstrating that short-term memory can hold only a limited number of elements simultaneously (Miller, 1956). Proponents of CLT suggest that learning interference is related to the amount of effort associated with thinking and reasoning and that some learning environments demand greater cognitive effort than others, thus requiring the learner's working (short-term) memory to use higher loads of information-processing resources (Bruning, Schraw, Norby, & Ronning, 2004; Mohana, Waters, & Deighan, 2008; Sweller, 1988; Sweller, van Merriënboer, & Paas, 1998). Long-term memory schemas serve as the cognitive architectural structures that comprise an individual's knowledge base; however, they are acquired over a lifetime of learning that involves linking knowledge with multiple concepts and experiences (Bruning et al., 2004; Sweller, 1988). Embedded within CLT are three

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types of cognitive load: intrinsic load, extraneous load, and germane load. The load placed upon the working memory is affected by the intrinsic nature of the learning tasks (intrinsic load), by the manner in which the tasks are presented (extraneous load), and by the learning that actually occurs (germane load) when handling intrinsic load (van Merriënboer & Sweller, 2010).

Intrinsic cognitive load is imposed by the inherent properties of the learning content itself, coupled with the level of expertise of the learner. All instruction has an inherent difficulty associated with it, but the perceived intrinsic load varies significantly between a novice learner and a more experienced learner. The intrinsic cognitive load generally cannot be manipulated by an instructor, unless the instructor breaks the content down into smaller chunks or scaffolds the information by adapting it to the learner's level of expertise (Mohanna et al., 2008; Vogel-Walcutt, Gebirim, Bowers, Carper, & Nicholson, 2011). However, extraneous cognitive load relates to how information is presented to learners and can be manipulated or controlled through instructional design. This load increases when information irrelevant to the learning is presented, thus placing an unnecessary demand on the learner's working memory and interfering with long-term memory acquisition (Mohanna et al., 2008; Vogel-Walcutt et al., 2011). Because the working memory is thought to have a limited capacity, using resources to process extraneous load results in a reduced amount of available resources to process the intrinsic and germane (learning) loads.

Germane load refers to the working memory resources that are used to cope with intrinsic cognitive load and lead to learning (van Merriënboer & Sweller, 2010). It involves all aspects in which the processing, construction, and automation of schemas occur so that presented information may be grouped together and organized in long-term memory. Germane load is not inherent to the content being taught, but rather is influenced by the instructional design of the learning content and the manner in which that content is presented. Therefore, the goal for instructional designers is to "reduce extraneous cognitive load and redirect learners' attention to cognitive processes that are directly relevant to the construction of schemas" (Sweller et al., 1998, p. 265).

Cognitive load theory has broad implications for the instructional design of learning material, given that it is understood that poorly designed instruction includes extraneous and distracting elements that overload the working memory and thus interfere with learning. Conversely, when information is presented in a clear, relevant, and germane design, more efficient acquisition is promoted (Vogel-Walcutt et al., 2011). Therefore, the aim of instructional design based on CLT is to prevent cognitive information overload by minimizing extraneous load, maximizing germane load, and optimizing intrinsic load (van Merriënboer & Sweller, 2010; Vogel-Walcutt et al., 2011). It is important to recall that the amount of intrinsic load is related to the learner's level of experience with the information. This factor should encourage educators to use scaffolding as a design strategy, as instructional techniques used to target novice learners may vary greatly from those used for experienced learners (van Merriënboer & Sweller, 2010).

Cognitive Load Theory and Pharmacology

The study of pharmacology requires students to apply knowledge from a variety of natural and applied sciences, in-

cluding anatomy, physiology, chemistry, and pathology. For the pharmacology course in this discussion, traditional approaches to teaching have included lecture, PowerPoint® presentations, the use of textbook resources, and explanations of pharmacokinetics and pharmacodynamics using a prototype approach to medication classification. The participants of this course typically include 96 junior-level baccalaureate nursing students, but the course is divided into two sections, each with approximately 48 students. Prior to instruction, students must meet the prerequisite pathophysiology course requirements, and during this course, they are concurrently enrolled in their first clinical course, in which they are taught health assessment, the nursing process, and fundamental basics for nursing practice. Each section meets a total of 15 times throughout one semester, and each class lasts 3 hours.

Method

By using CLT as a theoretical framework for this pharmacology course, the study attempted to adapt instructional content to meet the various student needs. Success in this course greatly depends on a strong pathophysiological knowledge base, and because of the high amount of inherent review material, the instructor wanted to reduce the amount of extraneous load for students comfortable with pathophysiology, while still providing review for those who needed it. Four instructional strategies were used to do this: (a) opening review activities, (b) providing students with lecture notes, (c) a "Top Five" approach to learning new drugs, and (d) deciphering "Need to Knows" from "Nice to Knows."

Opening Activities

Each learning experience began with active-learning opening activities. For students, these activities captured their attention, set the tone and direction for the class content, and reviewed and retrieved prior pathophysiological knowledge by activating and automating long-term memory. For the instructor, these activities allowed for quick assessment of the class' knowledge recall to determine whether additional review time was necessary. Examples of opening activities include playing a true/false game, collaborating on unfolding case studies, viewing YouTube videos of commercials for brand name medications, or conducting a large group debate and discussion.

Providing Students With Lecture Notes

A more intentional use of PowerPoint slides was integrated into the course to eliminate redundancy and decrease extraneous load. One feature of PowerPoint is a "Notes Page" presentation view, which divides a standard 8.5" × 11" page in half, with the presentation slide appearing in the top half and the notes section in the bottom half. For this course, the notes section of each slide provided a communication space for the instructor and students about lecture content. This content was written in a precise, nonextraneous, bullet-point style in which complex concepts were broken down into smaller, more manageable chunks of information. By using these slides to share important information, lectures were scaffolded so that the first portion of the class contained a brief review of information directly related to the pharmacological content for the day. During

lecture, students were then able to focus their attention on what the instructor was saying, rather than frantically trying to copy down notes to study later. Conversely, the instructor was free to engage with and respond to students.

The “Top Five” Approach

To eliminate extraneous load and decrease the intrinsic load associated with learning multiple medications, a “Top Five” approach was used to teach individual drug prototypes. Students were asked to consider the question: “If you could learn only five key take-home points about a drug, what would they be?” Then, the instructor guided and modeled this approach by using examples that centered on five general considerations: (a) drug classification and mechanism of action; (b) medication-specific or concerning adverse effects; (c) major contraindications; (d) nursing considerations (e.g., infusion rates, injection sites, laboratory tests); and (e) patient teaching considerations (e.g., dietary restrictions, monitoring education, safety information). As the semester progressed and students gained familiarity with this approach, the responsibility of identifying a drug’s “Top Five” shifted from the instructor to the students.

“Need to Knows” Versus “Nice to Knows”

The last 30 minutes of each class were spent using active-learning strategies that reviewed the day’s content to promote desired germane cognitive loads. During this time, the instructor ensured that students knew the “Need to Knows” versus the “Nice to Knows,” which allowed them to later focus their studying efforts solely on the most important aspects of the lecture (Bruning et al., 2004; Reynolds, 1993). The instructor openly defined the term “Need to Know” for students, which centers on the question: “What does a reasonable and prudent nurse need to know (about today’s content) in order to care for a patient with _____?” Information deemed “Nice to Know,” on the other hand, includes aspects of care that are important, but that are also readily available for students or nurses to review, read, or look up in their free time.

Results

Qualitative student feedback of these instructional strategies was obtained as part of the course’s final evaluation. Formal responses were collected over one academic year and were then compared between the two semesters. These instructional strategies did not receive any negative feedback. Providing students with lecture notes freed them to actively listen to the instructor rather than frantically scrambling to take notes. Whenever the instructor emphasized something specific, students could be directed to the exact location of that information in their notes section, where they could highlight it to later determine whether it was considered a “Need to Know” or a “Nice to Know.” Through informal feedback and conversations with students, the instructor learned that they enjoyed the activities that opened each learning experience, and the students even began requesting some of their favorites toward the end of the semester. The instructor thought these four instructional methods promoted a fun, engaging, student-centered environment, as students took more active roles in their learning. Furthermore, these methods freed up a significant amount of time traditionally

spent on lecture to be used on active and collaborative learning strategies. Actual face-to-face lecture time was reduced from 3 hours to 1 hour of divided lecture time, therefore allowing 2 hours to be devoted to in-class activities.

Discussion and Recommendations

Cognitive load theory proved to be a successful and effective theoretical framework for this undergraduate pharmacology for nursing course. The instructor used the premises of the theory to adapt instructional content to meet the various student needs, and the specific instructional strategies implemented received positive student feedback.

However, several tried-and-true recommendations were suggested for nurse educators considering the use of these teaching strategies within their classrooms. As this is a unique style of teaching, instructors need to be up-front with students about the notes feature within PowerPoint and demonstrate how to print them so students can effectively prepare for class. In addition, educators should be aware that embedding lecture notes into presentations can be time intensive and laborious, thus placing additional constraints on time. For students, it is crucial that they have a clear understanding of what a prototype is prior to adopting a “Top Five” approach for medications, given that there may be specific aspects about individual medications that are unique to that drug. For safety considerations, students should still look up individual medications prior to administering them in a clinical setting. Therefore, the concept of “Top Five” is used loosely as a guide and actually depends on the medication. For example, instructors may find that certain drugs have only “Top Three” things to know; conversely, high-alert medications may have “Top Ten” things to know.

Finally, and perhaps most importantly, the author of this study learned to refrain from giving the “Top Five” lists to students. Instead, these opportunities were used as theory burst strategies; specifically, after the discussion of a medication, students were given a few moments to collaborate within small groups and create their own “Top Five” lists. This activity sharpened the students’ critical thinking and clinical judgment skills, as they weighed the information and considered what was actually most important. Small-group responses were often shared with the larger group, allowing the instructor to model critical thinking through the discussion of rationales.

Conclusion

Today’s nursing students face many challenges, including heavy, content-laden curricula and learning environments that emphasize testing outcomes. Educators seek to support student-centered learning by motivating students and encouraging them to connect with and act upon their personal motivations. Cognitive load theory can be a successful and effective theoretical framework for undergraduate pharmacology and other nursing courses, thus assisting students and educators alike in overcoming these obstacles imposed on the learning environment.

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