Scaffolding Early Clinical Learning for Students in Communication Sciences and Disorders

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Abstract: Clinical practicum may appear to be the ideal setting for students to independently acquire clinical knowledge and skills through problem-solving. However, recent application of Cognitive Load Theory (CLT) to the fields of medicine and health sciences indicates that supported or scaffolded learning yields better outcomes for novice clinicians. This article discusses implications of CLT for students and clinical faculty/supervisors.

Students entering training in communication sciences and disorders anticipate clinical practice and the opportunity to apply in “real-life” what they are learning in the classroom about the development and disorders of communication. However, clinical practicum also provides opportunity for initial learning of skills that may not be introduced in academic coursework. The current ASHA certification standards outline the complex skill-learning targeted by clinical experiences (in Standard IV-G). These range in scope from selection and administration of assessment instruments and procedures, analysis and synthesis of assessment data, development and implantation of intervention plans, and counseling regarding clients’ communication needs. Connected with these practices is the learning of necessary administrative and reporting functions (ASHA, 2005). As clinical faculty and supervisors seek to assist students in acquiring these skills, they may see practicum as a space where students should engage in problem-based or discovery learning, using problem-solving searches to locate and then apply relevant disorder/treatment information. Supervisors likely anticipate that through this process students will achieve meaningful learning of discipline-specific knowledge and procedures. If clinical instructors employ a discovery-learning paradigm, they may offer minimal specific instruction or guidance in the belief that the more independently students carry out the process of problem-solving, the more they will learn (Kirschner, Sweller & Clark, 2006).

Minimal guidance in clinical learning settings probably does not coincide with student expectations; a survey of graduating seniors from the author's undergraduate CSD program indicated that the majority (53%) expected to have very close guidance and support during initial clinical experiences. None expected to "be thrown in at the deep end." Even more significant than student expectations is the research that indicates that minimal guidance or discovery learning is ineffective for initial knowledge and skill acquisition. Ayres and Paas (2012) note that there is little empirical evidence for minimally-guided learning, and the literature addressing novice learners indicates that its employment may be detrimental to their learning (Kirschner et al., 2006).

This article will provide an overview of Cognitive Load Theory (CLT) as an alternative to minimally-guided learning, and highlight how operating from within this framework will permit clinical faculty and supervisors to support clinical learning as the learner moves from novice to experienced. The term "scaffold" is used to denote providing adequate support for this process to occur, and modifying the degree of support as the learner changes. CLT, formerly applied primarily to areas such as mathematics and computer sciences, is now being directed toward the highly complex content of clinical learning within the health and rehabilitation sciences. The focus of CLT application is that of supporting learners as they direct available cognitive resources to the most necessary and important aspects of the content or skill to be learned.

Cognitive load theory refers to the structure of learning, and addresses the process by which information is first processed in working memory, organized into clusters of interrelated information (schemas) and finally stored in long-term memory (LTM) (Morrison, 2013). Working memory can hold only a limited number of units of information (famously, 5-9 elements, or 7 +/- 2). It can actively manipulate fewer (no more than 2-4 elements simultaneously). Duration of the information in working memory is less than 30 seconds. "Human working memory becomes increasingly prone to errors as learning tasks become more complex, such as when a novice learner is given instruction that requires him or her to simultaneously maintain and manipulate multiple elements of information for learning to occur. In contrast, long term memory can effectively store vast amounts of information including content knowledge, skills, and strategies on a relatively permanent basis" (Morrison, 2013, p.58). Meaningful learning is the result of this cognitive schema construction (through storage of information in the LTM.) Expertise is ultimately developed based on the quality and quantity of knowledge stored. Expertise development is aided by the automation of frequently used schemas (van Merrienboër & Sweller, 2010).

In considering how to support schema development for clinical learning, it is necessary to understand the different types of information that the learner is must process. Van Merrienboër and Sweller (2010) explain the three types of cognitive load commonly presented in the literature: **intrinsic load**, the actual content and complexity of the material or task to be learned; **extraneous load**, the way in which the content is presented to or encountered by the learner, and finally **germane load**, the content that is actually learned and stored in schemas. Kirschner, Sweller and Clark (2006) note that intrinsic load is affected by not only the complexity of the content to be learned but the learner's current expertise with that content. Extraneous load is impacted by anything that diverts the learner's attention and effort from that content; it can be increased by complex or confusing instruction about procedures, or limited explanations about content. Van Merrienboër and Sweller (2010) emphasize that intrinsic and extraneous loads are additive. It is because of this additive factor that problem-based/discovery learning is a weak model for novice learners; discovery learning overburdens working memory as the learner searches for potential solutions without the foundation of already organized schema to which new information can be attached. In such situations, new schemas are not created and long term memory storage does not occur. Schemas are acquired when working memory load is reduced so that cognitive resources can be directed to intrinsic content (Kirschner et al., 2006). The following are two principles from the study of CLT deemed applicable to clinical instruction and learning:

1) **New content and tasks to be learned vary in degree of challenge for the learner**. The complexity of the information to be learned varies to the degree that its elements (units or chunks) interact with each other. Morrison (2013) uses an example from the disciplines of occupational/physical therapy when he identifies the learning of the bones of the hand as a task with low element interactivity – each element/name or term can be processed serially (one at a time) and learned independently of one another. In contrast, a task requiring parallel processing, such as learning *how to* diagnose a back injury, requires simultaneous consideration and manipulation of a high number of elements. Such tasks are very difficult for the learner.

As van Merrienboër and Sweller (2010) note, well-designed instruction should not only encourage schema construction, but also schema automation for aspects of practice that are consistent across tasks. Automation frees working memory because an automated schema steers behavior without needing to be processed in working memory; in other words, a large group of elements can be learned and automated as a single schema which then becomes one element in working memory. Clinic intake procedures, or the steps involved in administering a variety of standardized tests, are examples of clinical tasks which should be learned to automation.

2) **The cognitive load of clinical instruction changes as the learner changes** (Kirschner et al., 2006). Learner characteristics, such as previously acquired schemas, problem-solving strategies, and level of engagement, as well as the complexity of the material to be learned, should bear on the instructional strategies employed (Morrison 2013). Morrison gives the example of a student learning to complete a patient interview; the medical student must maintain many elements of information simultaneously active in working memory in order to attend to patient responses, direct the interview as indicated, and recognize/categorize complexes of symptoms. A novice student in this situation, with little previously organized knowledge and few automated schemas for this process, is likely to have working memory overwhelmed by simply trying to recall the steps in the interview. Effective processing of the information leading to adequate clinical reasoning is highly unlikely and the probability of mistakes on the part of the student is high. However, the experienced clinician will likely have automated schemas controlling much of this procedure and will have adequate cognitive resources for focusing on the diagnostic importance of the information provided. White (2011), in discussing CLT in the context of clinical instruction for nursing, summarizes these

factors by saying that the instructor or supervisor must consider that the nature of the learning task, the nature of the environment, and the learner's perceptions of these elements all contribute to learning outcomes, positive or negative.

Keeping learner characteristics (novice vs. experienced) and content characteristics (simple vs. complex) in mind, then, consider the following strategies for scaffolding clinical learning by *minimizing or decreasing* extraneous load and *managing* intrinsic load so that germane load (what is actually learned) can be *optimized* (van Merrienboër & Sweller, 2010).

Decrease extraneous load: Extraneous load in clinical learning has much to do with the "how tos" of practice, and may involve everything from intake procedures (what forms are required), to use of client management software, to the steps involved in administration of specific assessment tools. These all involve learning that for the beginner is complex, yet for the experienced clinician is likely exists in LTM as automated schemas that don't require active processing. Intrinsic and extraneous loads are additive, according to van Merrienboër and Sweller (2010) and so the more extraneous load is decreased, the more resources can be devoted to the intrinsic cognitive load. This facilitates greater germane load.

One obvious way to minimize extraneous load in clinical learning is to control the number of clients that novice clinicians are expected to manage. Clinical directors and supervisors may wish to consider that the initial clinical experience should involve only *one* client while the student works on automatizing procedural schemas. For directors concerned with the acquisition of clinical clock hours at this early stage, a model emphasizing acquisition of the bulk of clinical hours (300 – 350) during the middle summer and final two semester of a traditional graduate program has been shown to be effective. Such a model allows for the first two semesters of study to focus on clinical schema building and automation of basic schemas as the student gradually accrues 50 – 75 hours (Austin & Taylor, 2013).

The following are some principles for decreasing extraneous load, as summarized from the literature by van Merrienboër and Sweller (2010) and now applied to the field of CSD:

a) Worked-example principle: replace discovery learning with worked examples to be studied. At the onset of learning, novices have weak problem-solving methods due to the limited amount of already organized information available to them, so problem-solving attempts cause high extraneous load. In the field of CSD, a worked example utilized in a clinical setting might be a prepared therapy plan that students study and analyze for its component elements, prior to being asked to independently create therapy plans.

b) Completion principle: replace conventional tasks with completion tasks, where partial solutions are provided. Here, the size of the task is reduced, so extraneous load is reduced. An example of a completion task in a clinical setting could be use of a report template which provides the report structure and wording, but has the student insert key information.

c) Split attention principle: replace multiple, distributed sources of information with integrated sources of information. Novice learners have difficulty selecting among multiple (and sometimes competing) information sources. For initial clinical experiences, extraneous load can be minimized by providing, for example, an integrated clinical procedures guide with linked documents.

d) Redundancy principle: replace multiple sources of information that are self-contained (or can be understood on their own) with only one integrated source of information. When new clinicians are asked to unnecessarily process redundant information, extraneous load is increased. If the supervisor is going to explain a procedure to a new clinician, the clinician should not be required to read the same information in a text as well. The supervisor should select one source or the other for use.

Manage intrinsic load: van Merrienboër and Sweller (2010) discuss the instructional and learning challenges of highly complex content/tasks. These are tasks in which the many elements are highly interactive, and must be processed in a parallel, "all at once" fashion (such as is the case with learning to conduct a diagnostic evaluation). In these cases minimizing the extraneous load alone may be inadequate for supporting learning. The combination of the intrinsic load and the remaining, unavoidable extraneous load may still add up to cognitive overload. The instructor may find it necessary to decrease the intrinsic load by simplifying the content of what is being learned. However, learning the simplified content should not be seen as the end-state of the learning to be achieved; the student will have only a reduced level of understanding. Therefore, multi-step strategies are called for in many cases of complex learning, where the content to be mastered is presented in stages of low to high element interactivity. When expertise has been developed, the impact of interactivity is reduced as the experienced person has an organized schema that incorporates those new elements--essentially this schema becomes a single element in short-term memory when it is activated. Van Merrienboër and Sweller (2010) outline two strategies for controlling intrinsic load:

a) Simple to complex strategy: this strategy addresses the sequence of instruction. Intrinsic load can be managed by first presenting isolated elements from the content or skill to be learned. Morrison (2013) discusses the implementation of this strategy, recommending that at the initial phase of instruction elements be introduced with limited or no discussion of how they interact. The isolated elements can be processed serially without overwhelming working memory. Then, in a second phase of instruction, all information required for understanding the concept is presented in a parallel manner focusing on learning and understanding the element interactions. Morrison terms this the "isolated/interacting element strategy" (p. 61), and notes a number of studies that show it to be particularly effective for knowledge acquisition for learners with low prior knowledge, in contexts where the intrinsic cognitive load is high. An example from CSD clinical instruction could be learning to conduct an oral mechanism examination. The isolated elements task would require students to learn and identify normal oral structures in a variety of individuals. Then, in an interactive elements presentation the instructor could review the full oral mechanism exam. The students could later conduct and write up a complete examination.

b) Low to high fidelity strategy: replace conventional tasks with tasks that are at first performed in a low-fidelity environment (decreased interactivity) and then in increasingly higher-fidelity environments. In the CSD clinical context, this may be visualized as first reading and reflecting on the significance of case history data within case studies, then conducting a case history interview within a computer simulation (now available for the discipline), and then finally completing the same task with a real client or patient.

Optimize Germane Load: The ultimate objective of instructional design from a CLT framework is to maximize the quality and quantity of relevant schemas that are stored within LTM. As learners move from novice to experienced clinicians, the following principles can be applied to increase the depth and breadth of the learning achieved:

a) Variability principle: Variable learning tasks increase the probability that similar features will be identified and relevant features/elements sorted from irrelevant. For example, when learning to identify a language impairment, clinical experiences can be provided with children with primary language impairment, children with autism, those with TBI, and so on. Exposure to variations on a skill helps learners determine the range of applicability of different schemas (van Merrienboër & Sweller, 2010).

b) Self-explanation principle: Tasks which require learners to self-explain information result in greater learning. Through this process prior knowledge elements are activated from long-term memory, thus increasing the number of interacting elements without increasing extraneous load (van Merrienboër & Sweller, 2010). An example from within CSD would be requiring students to complete and explain a decision-making tree regarding determination of the presence or absence of a language impairment. Reflections in the format of journaling or blog entries regarding specific learned skills would also involve the self-explanation effect.

The novice learner in CSD has a significant goal to achieve; that of constructing basic schemas in the area of clinical practice that can then be utilized to build expertise. *Once foundational learning has occurred*, research indicates that problem-based/discovery learning is effective. The instructional methods discussed above which are effective for novice learners result in redundancy for experienced learners (Kirschner et al., 2006). Independence in knowledge acquisition becomes not only a goal, then, for learners, but an effective instructional strategy which yields better learning outcomes -- for more knowledgeable clinicians. Until basic schema construction has occurred, however, a scaffolded approach to clinical learning will result in a stronger, better-built knowledge base.

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