EMPLOY A STRUCTURED APPROACH TO TEACHING PSYCHOMOTOR SKILLS TO ENHANCE LEARNER PERFORMANCE

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Introduction

The acquisition of surgical skills is essential to surgical practice. How these skills are taught and practiced has changed considerably over the past decade. The limitations associated with the "catch as catch can" model, the pressure to perform more procedures in a cost-efficient manner, the rising cost and unavailability of operating room time, concerns for patient safety, and the initiation of the 80-hour workweek restriction have all contributed to the need to move the teaching and learning of many psychomotor skills outside of the clinical arena and into a simulated environment. Although some programs have specifically-designed curricula, others remain unstructured and unsystematic. In addition, assessment measures are variable and the few validated assessment tools are infrequently used. Usually learners receive a global assessment rather than a formal and specific assessment with feedback of individual skills. This method of teaching is widely variable and critically dependent on the quality of teaching of the supervising physician.

The most important element of any simulation laboratory is a comprehensive curriculum and a structured approach to teaching skills. A consistent approach to teaching psychomotor skills will better prepare residents for the operating room experience. It has been shown that learning and practicing surgical skills in a systematic fashion that mirrors expected performance is most beneficial to long-term retention. The purpose of this article is to emphasize the need for a structured approach to teaching skills and to provide strategies that faculty can use to enhance surgical skill performance and increase training efficiency.

Phases of Skill Learning

The acquisition of surgical skills is more complex than that of other motor skills, largely due to the greater degree of cognitive involvement. Hence we use the term "psychomotor skill" rather than "motor skill" to emphasize the underlying cognitive elements. This cognitive element involved with acquiring surgical skills can be thought of as a schema that contains a procedural rule that organizes the kind and sequence of actions performed. Thus, psychomotor tasks are skills that involve the acquisition of two basic components: learning a new muscular movement and a procedural rule.
The development of a skill typically occurs in three phases\(^2\). During the \textit{cognitive phase} the learner is a novice. The novice begins to acquire the verbal information and procedural rule components of the skill. They learn what they are to do and in what sequence. This phase is guided by trial and error and performance is erratic. Retrieval of knowledge in this phase is labor-intensive and effortful. Explanations and demonstrations are required to achieve the cognitive learning requirements of psychomotor skills.

During the \textit{associative phase} two things happen. First, errors in the initial understanding of the skill are gradually detected and eliminated. Second, the connections among the various steps of the procedure are strengthened. The learner is still thinking about each step of the process but the task is executed more fluidly with fewer interruptions. The learner is able to associate the cognitive knowledge of the skill with the muscular movements required to perform the skill successfully. At this stage, the procedural rule is deepened and made meaningful by the actual physical activity that accompanies each step in the procedure. Although they are able to physically perform the procedure, a smooth, highly skilled performance is not likely.

Finally, with repeated practice, the \textit{autonomous phase} is reached. During this phase, the skill is fine-tuned, gains speed of execution, and ultimately loss of conscious access. In this phase, practice gradually results in smooth performance; the learner no longer needs to think about how to execute this particular task and can concentrate on other steps of the procedure. Practice and feedback allow the learner to progress from the jerky or fumbling efforts of the novice to the smooth, controlled, and apparently effortless actions that characterize the expert performance of a psychomotor skill.

\textbf{Steps of psychomotor learning}

As noted above, increased pressures and decreased teaching time have made it necessary for faculty members to capitalize on the time spent with learners and employ efficient methods of instruction. Providing a consistent and structured approach to teaching skills can better support learners as they progress through each phase of skill acquisition. Outlined below are the sequential steps of psychomotor skill learning that may assist faculty with this process.

1. \textbf{Preparation}  
   Whether it is in the operating room or in the simulation laboratory, it is important that the instructor is fully prepared to teach the skill. This process includes familiarity with the procedure and the equipment. In addition, it is important to become familiar with the skill level of the learner. Questions about prior performance of the same or similar skill, graduate level, and prior rotations is useful to provide targeted instruction.

2. \textbf{Conceptualization}  
   During this step the learner is provided with all of the cognitive elements of the skill. Information about the specific medical condition, indications, contraindications, pitfalls, common errors, and possible complications are necessary for the learner to understand the overall goal of the task. In addition, knowledge specific to the procedural skill, such as anatomy, steps of the procedure, function and operation of equipment, preoperative work-up and postoperative assessment are important to review. An introduction of the cognitive elements of the skill is essential for learners to acquire the procedural rule
component of the skill. In this stage, learners learn "what" to do and not necessarily "how" to do it.

3. **Visualization**
   The learner sees the skill performed in its entirety from beginning to end by an expert. This step is often omitted but is significant as it provides the basis for imitation and gives the learner a model of expected performance. It is important to note that visualization does not have to be done live; a videotape will frequently be a more feasible way to accomplish this step. Advantages of video visualization include the ability to use techniques such as slow motion, close-up detail display, and stopping to ask questions. Whether done by video or live demonstration, the sequential steps of the procedure, an explanation of “how” each step is performed and a focus on difficult steps, will augment skill acquisition.

4. **Verbalization**
   The instructor provides a narration of the steps of the procedure. It is helpful to divide the procedure into subtasks. This method helps the learner identify and follow the key steps in the correct manner and order. The learner should then be able to correctly describe the steps—this helps ensure that the learner understands the steps clearly. If the learner is able to narrate the steps of the skill before demonstrating it, there is greater likelihood that the learner can correctly perform the skill.

5. **Practice**
   Practice is a fundamental aspect of learning and perfecting psychomotor skills. Complex skills, such as performing a surgery, are refined over long periods of time involving deliberate practice. Deliberate practice is concentrated, highly structured, and comprised of activities that have been found to be most effective in improving performance. The number of hours spent in deliberate practice determines the level of expertise; however, it is generally agreed that expertise takes 10 or more years to develop. Engagement in deliberate practice, not just time and experience in clinical settings, may be the key to the development of surgical clinical competence.

   Other practice decisions that need to be made include scheduling (massed compared to distributed) and distribution (part compared to whole). Distributed practice (practice distributed over regular teaching sessions) has been shown to be superior over massed practice (practice distributed in large teaching blocks) in many domains. This finding is thought to be due to the fact that fatigue and boredom are detrimental to learning.

   Part practice entails splitting the procedure into two or three major steps to allow learners to do one step at a time until each step has been mastered. Once students have been able to demonstrate each step of the procedure they should be allowed to perform the whole procedure under supervision. Part practice more closely mirrors teaching in the operating room, where the supervising physician allows learners to perform portions of the case; however, there is some evidence that practicing the entire task (whole practice) results in the most learning.
6. **Feedback**

Feedback is essential to help learners achieve proficiency in technical skills. Without it, mistakes go uncorrected and become part of the trainees' everyday performance. Once faulty skills become automated, it is difficult to retrain the learner to the correct technique. The best feedback is specific and timely. For example, the statement, "You are holding the instrument two inches too far to the right," is much more specific than, "You are holding the instrument too high." In addition, feedback should focus on actual observations and should not be given prematurely. Constructive feedback conveys an attitude of concern regarding progress and is valued by most learners.

To reinforce learning, each operative procedure can be followed by a debriefing session. Video recording followed by a review of this recording by both instructor and trainee can cement correct performance, identify mistakes, and help move learners toward competency.

7. **Mastery**

Mastery is the ability to routinely perform a sequence of skills in practice situations without error. To facilitate mastery of a skill, faculty can arrange for contiguity and repetition. When possible, faculty may arrange to work with the same resident everyday in order to facilitate repetition and provide opportunities for practice. Faculty can observe performance and offer feedback by reinforcing what is right, correcting errors, and teaching fine points of the skill.

8. **Autonomy**

The last step of psychomotor learning is autonomy. Autonomy is reached when a trainee demonstrates the ability to regularly perform the skill in real life situations without error.

**Assessment**

Effective evaluation techniques should be coupled with good teaching strategies. Without an accurate assessment, it is difficult to determine the competency of the learner. Many programs continue to use a subjective approach to psychomotor skill evaluation despite the fact that validated and reliable instruments have been developed. Options for a more structured approach to evaluation include the use of a checklist or rating scale. Items on these instruments can be either global in nature (for example, assess skills applicable to all procedures such as *respect for tissue and instrument handling*) or procedure specific. Other assessment tools that can be used to evaluate technical skills include the Objective Structured Assessment of Technical Skills (OSATS), the McGill Inanimate System for Training and Evaluation of Laparoscopic Skills (MISTELS), and the Fundamentals of Laparoscopic Surgery Examination (FLS). Ideally, a verification of proficiency (VOP) system that allows for advancement once competence in subordinate skills has been shown is recommended.

Regardless of the type of instrument selected to assess psychomotor skills, it should target the features and anchors that are most critical for the skill and the level of the learner. The assessment of the cognitive piece of the psychomotor skill can be assessed in the same way as other cognitive tests. Consistent and accurate evaluation is necessary to ensure surgical proficiency in technical skills.
Summary

The acquisition of psychomotor skills is essential to the practice of surgery. If the instructor employs a consistent and structured approach to teaching technical skills, he or she may enhance learner performance and assist faculty in this process.

References


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