

1. **Date Submitted:** 4/17/2009
2. **Project Title:** Comparison of Four Pedagogical Approaches to Psychomotor Skills Acquisition
3. **Project Theme:** Promote innovative teaching techniques that may lead to continuous improvement in learning outcomes

4. **Applicant/Project Director Name:**

Name: Ross Willis, PhD

Department/Title: Surgery

Address: Mail Code 7737, 7703 Floyd Curl Dr, San Antonio, TX 78229-3900

Campus Phone: 7-5721

Email: willisr@uthscsa.edu

Fax: 567-2347

5. **Name and Title of Co-Project Directors:**

Name:

Department/Title:

Address:

Campus Phone:

Email:

Fax:

Name:

Department/Title:

Address:

Campus Phone:

Email:

Fax:

6. **Name of Administrative Staff Contact:**

Name: Ross Willis, PhD

Department/Title: Surgery

Address: Mail Code 7737, 7703 Floyd Curl Dr, San Antonio, TX 78229-3900

Campus Phone: 7-5721

Email: willisr@uthscsa.edu

Fax: 567-2347

7. **Requested dollar amount (up to \$5,000 is available):**

\$4200

## Comparison of Four Pedagogical Approaches to Psychomotor Skills Acquisition

### Statement of Need

Traditionally, surgical educators have approached psychomotor skills acquisition via the constructivist-based "see one, do one, teach one" Halstedian technique. Other common pedagogies include time-based ("see one, do several in a specified period of time", e.g., 1 hour) and repetition-based ("see one, do a specified amount of repetitions", e.g., 5 trials) methods. In each of these teaching methods, an expert demonstrates proper technique and observes trainees' performances and offers feedback. In some cases, an expert surgeon uses an informal checklist to document technical proficiency to some degree, usually by observing performance on one trial of the task. The student-to-teacher ratio is often low, which makes it difficult to implement these pedagogical approaches in a laboratory environment in which there are several trainees and only one instructor. The instructor simply does not have enough time to devote individual attention to each trainee and as such, trainees often are forced to learn from other trainees (i.e., fellow novices). While relatively easy to implement, none of these pedagogies ensure that a trainee has truly mastered the skill to ensure consistency and short- and long-term retention.

More recently, a small portion of the surgical community has implemented a form of Bloom's (1968) Learning for Mastery model renamed "proficiency-based training." In the proficiency-based training model, an instructional designer conducts behavioral and cognitive task analysis by observing several experts performing a task. During the task analysis, important aspects of the experts' performance are recorded, such as time to completion, suture symmetry, wound approximation, knot strength and security, and appropriate decisions. For example, in a laparoscopic intracorporeal suturing task in a box trainer, the surgeon is required to use laparoscopic instruments and suture to close a wound in a model that simulates a vascular anastomosis. Dependent measures may include appropriate placement of the suture across the wound, the number of needle "bites" required to run the suture and tie knots, whether the wound was properly closed, whether the sutured wound leaks by running pressurized liquid through the model, whether the knot bursts under pressure, whether knot security is compromised with gaps between throws, and the amount of time required to complete the task. After observing several experts, the instructional designer creates a single score which represents whether the surgeon has passed or failed the task. A mastery criterion is set by requiring trainees to achieve a passing score on some number of trials. Examples of mastery criteria currently used in the surgical education literature (Brydges et al., 2008; Gallagher et al., 2005; Heinrichs, et al., 2007; Scott et al., 2007; Stefanidis et al., 2006; Van Sickle et al., 2007) include passing scores on 3 consecutive trials, passing scores on 10 nonconsecutive trials, and 3 passing scores on consecutive trials plus passing scores on 10 nonconsecutive trials. These mastery criteria seem to be chosen arbitrarily rather than on empirical data.

After mastery criteria have been set, the instructional designer creates a narrated video of an experienced surgeon performing the task and/or written documentation of correct task performance. During training, each student visits the skills laboratory and trains at his/her individual pace. Training requires the student to watch the video and/or read the written documentation, perform trials of the task, and score his/her own performance on each performance. The student trains on the task until he/she achieves the specified mastery criterion.

Proficiency-based training requires relatively more development time because mastery levels must be identified and a scoring schema must be created. Additionally, the proficiency-based training paradigm may require more training time than earlier surgical education models. However, the main benefit of proficiency-based training is that by allowing training time to vary and keeping mastery constant, trainees receive a personalized training regiment based on the individual's performance rather than outside influences such as time or class size. As such, it is believed that proficiency-based training will yield superior short- and long-term retention compared to more traditional approaches to training. Despite the hypothesized benefits of the proficiency-based training paradigm, the medical education community has not readily accepted this form of training.

The proposed study will compare the Halsteadian, time-based, repetition-based, and proficiency-based pedagogical approaches to psychomotor skills acquisition in terms of training time and short- and long-term retention. It is important to compare various pedagogical approaches to teaching psychomotor skills because in this era of limited work hours, residents have less time to learn increasingly complex technical skills. If the data support the hypothesis that proficiency-based training can result in better short- and long-term retention, then it could be set forth as the preferred model for psychomotor skills acquisition training in surgery, as well as other procedure-based areas of medical training.

### **Design**

The intracorporeal suturing task from the Fundamentals of Laparoscopic Surgery (FLS) program will serve as the instructional domain used to assess the relative effectiveness of each pedagogical approach in this study. A total of 60 of first-, second-, and third-year medical students will be recruited as research participants. Medical students represent an ideal research population because (a) there is not a sufficient number of surgery residents in the early stages of training available, (b) medical students do not have sufficient domain-specific prior knowledge, and (c) surgery residents often cannot find sufficient time to participate in research projects. Participants will be assigned to one of four groups, with 15 participants in each group, based on a random stratified assignment method. Stratification will be based on gender and year in medical school.

#### Halsteadian Training Group

In the Halsteadian Training Group, an expert (i.e., PGY-3 surgery resident with sufficient laparoscopic experience) will demonstrate proper technique for the task. The student will then perform the task with guidance from the expert. Next, the student will teach the expert the proper technique for the task while the expert performs the task under the student's guidance. Training time will be recorded. To assess short-term retention, the student will perform the task without the expert's guidance and the performance will be scored using a standard scoring rubric that assesses knot strength and security, suture placement, pattern cut accuracy, and time to completion. After a 4-week delay, the student will return to the laboratory and perform the task to assess long-term retention.

#### Time-based Training Group

In the time-based Training Group, an expert will demonstrate the intracorporeal suturing task. The student will then perform one trial of the task with the expert's guidance. At this point, the

student will be allowed to perform the task as many times as possible in a 30-minute time limit. Number of repetitions will be recorded. At the end of this training period, the student's performance will be scored and timed for short-term retention. After a 4-week delay the student will return to the laboratory and perform the task again to assess long-term retention.

#### Repetition-based Training Group

In the Repetition-based Training Group, an expert will demonstrate the task. The student will then perform one trial of the task with the expert's guidance. At this point, the student will be allowed to perform the task 20 times. Training time will be recorded. At the end of this training period, the student's performance will be scored and timed for short-term retention. After a 4-week delay the student will return to the laboratory and perform the task again to assess long-term retention.

#### Proficiency-based Training Group

In the Proficiency-based Training Group, participants will train to the proficiency levels as reported by Scott et al. (2008). The following table lists the proficiency level for the intracorporeal suturing task:

<b>Allowable Errors</b>	<b>Proficiency Time (seconds)</b>	<b>Number of Repetitions Required</b>
Up to 1 mm accuracy or gap error No knot insecurity No model avulsion	112	2 consecutive + 10 nonconsecutive

Each student will have access to the skills laboratory to complete training at his/her pace over a period of 5 days. The student will have access to and may view a demonstration video as often as he/she wishes. At the end of this training period, the student's performance will be scored for short-term retention. After a 4-week delay the student will return to the laboratory and perform the task again to assess long-term retention.

This study is innovative because it directly compares three traditional methods of instruction to an emerging teaching methodology that may enhance students' procedural skill acquisition. To date, no studies have assessed the relative efficacy of these training techniques. The results may pave the way for a new way of teaching psychomotor skills in medical/surgical education.

#### **Potential Impact**

The objectives for this project are:

- Determine whether proficiency-based training is a viable and more efficient training method for psychomotor skills in medical and surgical education.
- Encourage other programs within UTHSCSA and around the country to move toward the proficiency-based training paradigm of training psychomotor skills. Encouragement will come in the form of publication of these data and presentations at local (e.g., faculty development sessions on the UTHSCSA campus), regional (e.g., Texas Association of Surgical Skills Laboratories), and national (e.g., Association of Surgical Education) conferences.

**Evaluation Plan**

The first objective (i.e., determining whether proficiency-based training is viable and more efficient than traditional training methods) will be assessed by analyzing the data collected in this study. Training time data for each of the four conditions will be compared using analysis of variance (ANOVA). For the Halsteadian, repetition-based, and proficiency-based training groups, training time will vary among participants. For the time-based group, training time will be the same for all participants (i.e., 30 minutes).

Training repetitions data for each condition will be compared via ANOVA. For the Halstedian group, repetitions will be the same for all participants (i.e., 1 guided trial + 1 teaching trial). For the repetition-based group, repetitions will be the same for all participants (i.e., 1 guided trial + unguided 5 trials). For the time-based group, repetitions will vary among participants (i.e., 1 guided trial + n unguided trials). For the proficiency-based group, repetitions will vary among participants.

Short- and long-term procedural skill retention data will be analyzed via ANOVA using performance score and completion time as dependent measures.

The second objective (i.e., encouraging other programs to implement proficiency-based training to teach psychomotor skills) will be assessed longitudinally by frequently monitoring PubMed and conversing with fellow medical/surgical educators. It is expected that proficiency-based training will become a training standard, but acknowledged that this will take time.

**Plan for Continuation**

Due to the nature of this project, there is no plan to continue this research beyond this initial funding period. However, potential continuation projects will involve developing additional psychomotor skills curricula using the proficiency-based training methodology (e.g., vascular and bowel anastomotic techniques, laparoscopic cholecystectomy, and laparoscopic Nissen fundoplication).

**Budget Plan and Cost Sharing**

Please refer to the attached budget worksheet.

## Proposal Budget Worksheet

Name of Project: Comparison of Four Pedagogical Approaches to Psychomotor Skills Acquisition

Name of Applicant/Project Director: Ross Willis, PhD

Date Submitted: 4/17/2009

Budget Category: Non-Personnel	Budget Justification	STG	Cost Sharing *	Amount
Project Supplies	Suture	\$450		\$450
Purchased Services (i.e. Academic Technology Services)	2.5 hours of video recording	\$300		\$300
Transportation/Travel				
Printing and Duplication				
Publications and Periodicals				
Equipment	Minimal Access Therapy Technique (MATT) Laparoscopic Trainer	\$2700		\$2700
Other:	Participant incentives (\$20/participant)	\$1200		\$1200
Other:				
Miscellaneous/Contingency				
<b>TOTAL BUDGET --- Project Request</b>		<b>\$4650</b>		<b>\$4650</b>

Cost Sharing \* ---- identify other cash or in-kind funding resources available to implement to the proposed project

## References

- Bloom, B. S. (1968). Learning for mastery. Evaluation Comment, 1, 1-12.
- Brydges, R., Kurahashi, A., Brummer, V., Satterthwaite, L., Classen, R., & Dubrowski, A. (2008). Developing criteria for proficiency-based training of surgical skills using simulation: Changes in performance as a function of training year. Journal of the American College of Surgeons, 206, 205-211.
- Gallagher, A. G., Ritter, E. M., Champion, H., Higgins, G., Fried, M.P., Moses, G., Smith, C. D., & Satava, R. M. (2005). Virtual reality simulation for the operating room: Proficiency-based training as a paradigm shift in surgical skills training. Annals of Surgery, 241, 364-372.
- Heinrichs, W. L., Lukoff, B., Youngblood, P., Dev, P., Shavelson, R., Hasson, H. M., Satava, R. M., McDougall, E. M., & Wetter, P. A. (2007). Criterion-based training with surgical simulators: Proficiency of experienced surgeons. Journal of the Society of Laparoendoscopic Surgeons, 11, 273-302.
- Scott, D. J., Goova, M. T., & Tesfay, S. T. (2007). A cost-effective proficiency-based knot-tying and suturing curriculum for residency programs. Journal of Surgical Research, 141, 7-15.
- Scott, D. J., Ritter, E. M., Tesfay, S. T., Pimentel, E. A., Nagji, A., & Fried, G. M. (2008). Certification pass rate of 100% for fundamentals of laparoscopic surgery skills after proficiency-based training. Surgical Endoscopy, 22, 1187-1893.
- Stefanidis, D., Korndorffer, J. R., Black, F. W., Dunne, J. B., Sierra, R., Touchard, C. L., Rice, D. A., Markert, R. J., Kastl, P. R., & Scott, D. J. (2006). Psychomotor testing predicts rate of skill acquisition for proficiency-based laparoscopic skills training. Surgery, 140, 252-262.
- Van Sickle, K. R., Ritter, E. M., McClusky, D. A., Lederman, A., Baghai, M., Gallagher, A. G., & Smith, C. D. (2007). Attempted establishment of proficiency levels for laparoscopic performance on a national scale using simulation: The results from the 2004 SAGES minimally invasive surgical trainer – virtual reality (MIST-VR) learning center study. Surgical Endoscopy, 21, 5-10.