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# Teaching Procedural Skills: Integrating Educational Theory Into Practice

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## Abstract

**Introduction:** Teaching procedural skills is an essential part of health professions education, yet formal training is often lacking from traditional curricula. **Methods:** A workshop on teaching procedural skills was developed as part of a clinician educator track at a large health professions university. Participants included medical residents and fellows (postgraduate years 2-6) from various training programs. The 90-minute, interactive training integrated Gagne's model of instructional design with evidence-based teaching practices. Workshop outcomes were evaluated with pre- and postworkshop surveys. Learner reactions (Kirkpatrick level 1) were assessed via course evaluation. Learning and behavior (Kirkpatrick level 2) were evaluated via attitudinal and knowledge-based questions. Data were collected from three cohorts of participants (2022-2024). Responses were analyzed by paired *t* test. **Results:** Residents and fellows from 11 different disciplines participated in the workshops. The survey response rate was 30 out of 35 (86%). Course evaluations were positive for all six questions (mean scores: 4.8-5.0 on a 5-point Likert scale [1 = *strongly disagree,* 5 = *strongly agree*]). Postworkshop scores improved significantly for all five attitudinal questions, including "I can apply instructional design theory when teaching procedural skills" (pre: 2.2 vs. post: 4.3 on a 5-point scale, $p < .01$). The number of participants correctly answering the knowledge-based questions also increased following the workshop. **Discussion:** A workshop focused on evidence-based teaching of procedural skills was well reviewed and improved participants' attitudes and knowledge. Strengths of the workshop include its appeal to a broad range of medical trainees, integration of educational theory, and interactive design.

**Keywords**

Instructional Design, Educational Theory, Procedural Skills, Clinical Teaching/Bedside Teaching, Clinical/Procedural Skills Training

## Educational Objectives

By the end of this activity, learners will be able to:

1. Apply Gagne's model of instructional design to teaching procedural skills.
2. Apply Peyton's four-step model for teaching procedural skills.
3. Define and apply the elements of deliberate practice.

## Introduction

Procedural skills are defined as "the mental and motor activities required to execute a manual task."[1] In recent years, traditional methods for teaching procedural skills such as "see one, do one, teach one" have given way to simulation-based training.[2] This approach is more effective for long-term skills acquisition and is associated with improved patient outcomes.[3,4] The shift from eminence-based to evidence-based teaching practices also acknowledges the evolution of learners' needs. Current pedagogical models for procedural training consider the progression of skills from the simulation environment to the patient care setting and beyond to the maintenance of competency over time.[1,5] Despite the apprenticeship-based model of medical training, formal preparation in teaching procedural skills is often lacking from postgraduate medical education. Senior house officers are frequently responsible for supervising junior trainees in performing procedural skills, despite research suggesting they are often not prepared for this role.[6-8]

Few published resources provide curricular content for procedural skills training interventions. Patton and colleagues described a half-day workshop targeting second-year internal medicine residents.[9] That training focused on concepts of deliberate practice and purposeful interruption via simulated central venous catheter (CVC) placement. The authors noted that a limitation to their intervention was the number of resources required to train four to six residents, including time (3-4 hours), facilitators (two to four faculty), and simulation equipment.

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The focus on CVC may also limit generalizability. Jhaveri and colleagues described an eight-step intervention for training internal medicine residents to teach peripheral IV insertion via an objective structured teaching encounter, with its instructional framework informed by educational theory.[8] The course was well received by participants but failed to show improved performance by downstream learners, in part because of the small sample size. Course materials were not published for this intervention.

The workshop described here was designed to address some of these limitations. The goals of the workshop were to improve participants' confidence in and knowledge of applying educational theory and evidence-based practices for teaching procedural skills. The workshop allowed for larger learner groups and fewer facilitators and did not require the use of simulation mannequins. Because our target audience included residents and fellows from different specialties and subspecialties, the workshop focused on general principles that could be translated to the specific needs of the participants.

## Methods

We developed a workshop for teaching procedural skills as part of a clinician educator track (CET) at the University of Nebraska Medical Center.[10] Two internal medicine faculty members with experience in procedural teaching developed and facilitated the training. The target audience was medical residents and fellows from different training specialties enrolled in the CET (postgraduate years 2-6). No prerequisite knowledge was required. The 90-minute workshop took place in a lecture room large enough to accommodate approximately 20 learners. Tables were arranged to allow small groups to interact during the workshop activities. Each participant received a packet including a role-play exercise and reference sheet outlining the relevant theories and models (Appendix A). Audiovisual equipment included a computer and projection screen for presenting didactic material via Microsoft PowerPoint (version 2016).

The course designers adopted the Gagne model of instructional design for the workshop. This approach derives from information processing theory, which tries to explain how information is encoded into memory.[11] Gagne's model considers the internal and external conditions of learning to create a practical, stepwise series of instructional events that have been applied to many topics, including teaching procedural skills.[12,13] The nine instructional steps are as follows:

1. Gaining attention.
2. Informing the learner of the objectives.
3. Stimulating recall of prior learning.
4. Presenting new material.
5. Providing learning guidance.
6. Learner performance of the procedure.
7. Providing feedback.
8. Assessing the performance.
9. Enhancing retention and transfer.

Recognizing the importance of the bedside teaching components, the course designers wanted to provide more detailed instruction for how to offer learning guidance and support learner performance (steps 5 and 6). To accomplish this goal, we integrated an evidence-based approach to teaching clinical skills, Peyton's four-step model, into the Gagne instructional design framework, as has been previously described.[14,15] In a meta-analysis, students receiving skills training using Peyton's model had higher skills performance scores and required less time to complete the procedure than students receiving traditional teaching methods.[16] Peyton's model includes the following steps[17,18]:

1. Demonstration—teacher performs the skill without explanation.
2. Deconstruction—teacher performs the skill while explaining each step.
3. Reconstruction—teacher performs the skill while the learner explains each step.
4. Performance—the learner performs and describes the skill.

Within the final instructional design step, we integrated the concept of deliberate practice to enhance the retention and transfer of skills. Deliberate practice is a structured and purposeful system of repetition meant to promote continual improvement. In a meta-analysis, integrating deliberate practice into simulation training proved superior to traditional teaching methods.[2]

The workshop started with introductions and informal discussion of the participants' experiences performing and supervising procedures. A facilitator then began the didactic portion of the workshop (Appendix B), following the course agenda (Appendix C). After introducing the definition of procedural skills, we described Gagne's model of instructional design in a step-by-step manner. Within the context of Gagne's model, we described other relevant concepts, including Peyton's four-step model of skills training, providing feedback, and deliberate practice. The didactic presentation was broken up at regular intervals by interactive, small-group exercises in which participants applied Gagne's model to create a handwashing curriculum. We chose

handwashing for the role-play activity for several reasons. First, it was widely applicable across health care professions and disciplines. Second, it required few resources: We provided each partner group with a small bottle of hand lotion to simulate hand sanitizer, which cost under $10. Third, the workshop was introduced in 2022 when handwashing was particularly relevant because of the COVID-19 pandemic.

We designed the workshop to improve participants' confidence in and knowledge of applying educational theory and evidence-based practices for teaching procedural skills. We evaluated the workshop with paired pre- and postworkshop surveys that we created (Appendices D and E). Each participant created a unique identifier that allowed data to be tracked and paired. The preworkshop survey included demographics and data regarding participants' procedural experience. We evaluated educational outcomes through the prism of the Kirkpatrick model.[19] Learner reactions (level 1) were assessed via a six-question course evaluation. Learning and behavior (level 2) were evaluated via five attitudinal questions and three knowledge-based questions, two of which were added in the third year of the workshop to evaluate course objectives more fully. The postworkshop survey included open-ended questions asking participants to share beneficial aspects of the workshop and areas for improvement. Electronic surveys were created within Microsoft Forms. We emailed a link to the precourse survey the week before the workshop. Participants accessed postcourse surveys via QR code link immediately following the workshop. SPSS version 26 was used to analyze matched pre/post responses, and a paired *t* test with a *p* value of less than .05 was considered statistically significant.

## Results

We collected data from three cohorts of participants over 3 years (2022-2024). Thirty out of 35 participants completed both pre- and postworkshop surveys (response rate: 86%). Learner characteristics are displayed in Table 1. Trainees from 11 different disciplines participated in the workshop, including 18 residents and 12 fellows (postgraduate years 2-6). Learners varied in their procedural experience, ranging from 0 to >20 procedures performed and supervised in the prior 3 months. Only two participants (7%) reported prior training in teaching procedural skills.

Course evaluations were positive for all six questions, with a mean range of 4.8-5.0 on a 5-point Likert scale (1 = *strongly disagree,* 5 = *strongly agree*; Figure 1). Postworkshop scores improved significantly for all five attitudinal questions (Figure 2), including "I can apply instructional design theory when teaching procedural skills" (pre: 2.2 vs. post: 4.3, $p < .01$). The number of participants correctly answering the knowledge-based question regarding Peyton's four-step model improved significantly from 0% ($n = 0$ out of 30) to 90% ($n = 27$, $p < .01$). The knowledge-based questions added in the workshop's third year also improved following the survey, although the small sample size did not allow for testing of significance. The question regarding Gagne's model improved from 22% ($n = 2$ out of 9) to 56% ($n = 5$), and the question addressing deliberate practice improved from 44% ($n = 4$) to 78% ($n = 7$).

**Table 1.** Workshop Participant Characteristics, 2022-2024 ($N = 30$)

| Characteristic | No. (%) |
|---|---|
| Sex | |
| Female | 14 (47) |
| Male | 16 (53) |
| Training level | |
| Resident | 18 (60) |
| Fellow | 12 (40) |
| Training year | |
| PGY 2 | 9 (30) |
| PGY 3 | 6 (20) |
| PGY 4 | 5 (17) |
| PGY 5 | 8 (27) |
| PGY 6 | 2 (7) |
| Training specialty | |
| Allergy | 1 (3) |
| Anesthesia | 1 (3) |
| Cardiology | 1 (3) |
| Emergency medicine | 4 (13) |
| Gastroenterology | 2 (7) |
| Infectious disease | 3 (10) |
| Internal medicine or internal medicine-pediatrics | 13 (43) |
| Nephrology | 2 (7) |
| Physical medicine and rehabilitation | 1 (3) |
| Pulmonary critical care medicine | 2 (7) |
| Number of procedures performed in the past 3 months | |
| None | 7 (23) |
| 1-10 | 12 (40) |
| 11-20 | 2 (7) |
| >20 | 9 (30) |
| Number of procedures supervised in the past 3 months | |
| None | 14 (47) |
| 1-10 | 10 (33) |
| 11-20 | 3 (10) |
| >20 | 3 (10) |

We also evaluated how prior procedural experiences correlated with postworkshop survey responses (Table 2). The number of procedures performed correlated strongly with the number of procedures supervised ($r = .736$, $p < .01$.), moderately with confidence in ability to perform procedures ($r = .600$, $p < .01$), and weakly with confidence in teaching procedural skills ($r = .368$, $p = .04$).[20] There were no significant correlations between the number of procedures performed or supervised and applying instructional design, providing feedback, or understanding deliberate practice. In open-ended comments,

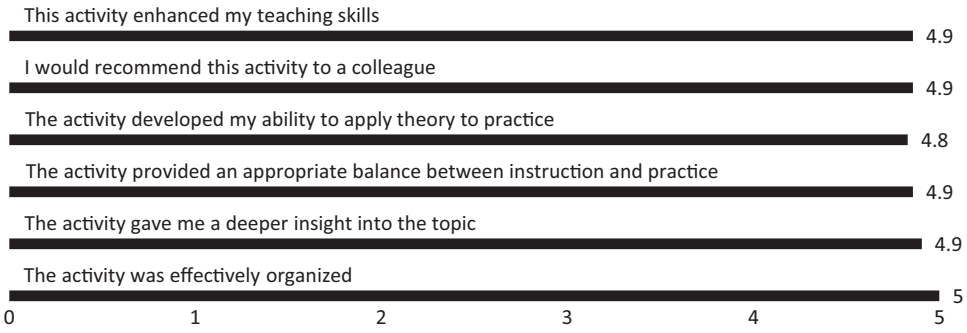


**Figure 1.** Course evaluation results for the teaching procedural skills workshop ($N = 30$). Mean values are reported, as measured on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

participants reported that the interactive exercises with application of theory to practice were especially beneficial.

## Discussion

A teach-the-teacher workshop focused on theoretical and evidence-based approaches to procedural skills training was well liked and improved participants' attitudes and knowledge. This workshop is valuable in that it provides a scaffolding framework for emerging educators who have historically had little guidance in making the leap from doing to teaching procedural skills.[8] The lack of significant correlation between the number of procedures performed or supervised and participants' confidence in applying

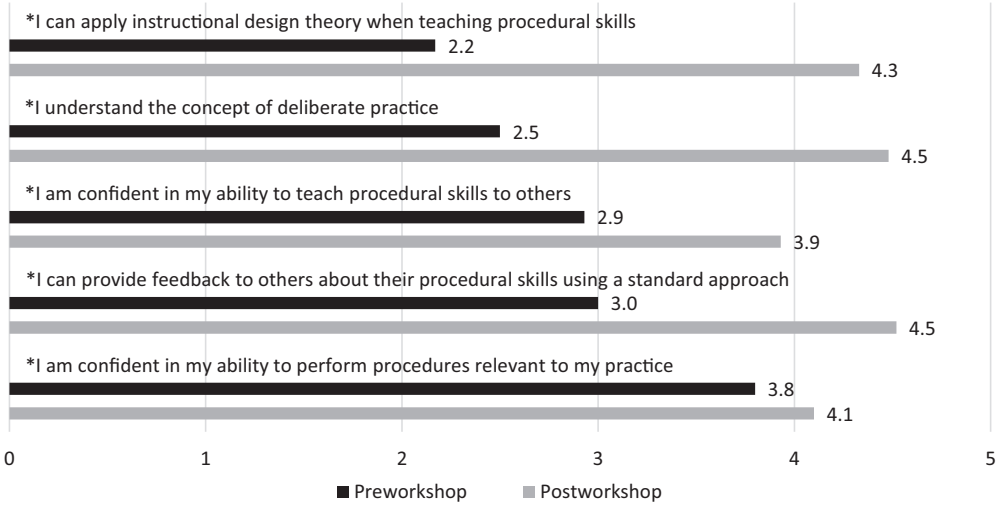


**Figure 2.** Participants' attitudes before and after the teaching procedural skills workshop ($N = 30$). Mean values are reported, as measured on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). *$p \leq .01$.

**Table 2.** Correlation Between Procedural Experience and Postintervention Survey Responses

| Survey Item | Number of Procedures Performed | | Number of Procedures Supervised | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Number of procedures performed | 1.000 | N/A | .736 | <.001 |
| Number of procedures supervised | .736 | <.001 | 1.000 | N/A |
| I am confident in my ability to perform procedures relevant to my practice | .600 | <.001 | .429 | .02 |
| I am confident in my ability to teach procedural skills to others | .368 | .04 | .459 | .01 |
| I can apply instructional design theory when teaching procedural skills | −.346 | .06 | −.071 | .71 |
| I can provide feedback to others about their procedural skills using a standard approach | .170 | .37 | .232 | .22 |
| I understand the concept of deliberate practice | −.239 | .20 | −.154 | .42 |

Abbreviation: N/A, not applicable.

instructional design theory, providing feedback, or understanding deliberate practice suggests that simply having more procedural experience does not necessarily translate to better teaching. We feel this underpins the importance of our workshop in providing formal training in teaching procedural skills.

The workshop was comprehensive in considering the continuum of procedural skills development from introductory didactic information to higher-stakes clinical learning environments involving patient care. It was also broadly applicable to a diverse group of learners, as it emphasized the framework for teaching procedures, rather than focusing on a particular procedure. While we used handwashing as an example for the small-group exercise because of its broad appeal across professions, it could be replaced with a more discipline-specific procedure if the learners come from a similar background. This workshop could also be used as introductory content prior to more specialized procedure skills training. Finally, the integration of the concept of deliberate practice affords a step towards self-monitoring and maintenance of teaching procedural skills that may reenforce knowledge and attitudes beyond the isolated workshop. The workshop was successful in presenting this material effectively and efficiently to residents and fellows from different specialties. While we had two faculty for 10-15 learners per session, the number of participants could easily be scaled to accommodate larger groups.

We encountered several challenges when developing and implementing this workshop. In our attempt to develop an evidence-based framework, we integrated multiple theories and teaching practices. This has the potential to confuse participants who may not have background knowledge of educational theories, so care should be taken in clearly describing the relevance and practical application of each concept. Furthermore, targeting medical trainees from different disciplines requires the content and activities to be generalizable. This “wide, not deep” approach may be challenging for learners with more highly specialized procedural practices (e.g., advanced endoscopy or invasive surgeries). We acknowledged this issue during our workshops and encouraged each participant to consider how they could apply course content to their individual practice. We also discussed how one element of skills retention, mastery, and transfer is advancing from simple to more complex multistep procedures.

There are several limitations in considering this workshop. Although we evaluated three cohorts over a 3-year period, the total sample size was still relatively low. Selection bias was possible, as the participants were enrolled in a CET and may have been more receptive to the course content than an unselected audience. We also recognize that our evaluation focused on short-term, lower-level educational outcomes (Kirkpatrick levels 1 and 2), relying primarily on self-reported levels of confidence, knowledge, and skills. Additionally, knowledge-based questions evaluated objectives lower on Bloom’s taxonomy.[21]

Future areas of study may include evaluation of higher-level educational outcomes using high-fidelity assessment modalities such as an objective structured teaching encounter. We are also interested in expanding the training to include junior faculty and other health professions.

In conclusion, we have described the development, implementation, and evaluation of a workshop for teaching procedural skills training to graduate medical trainees from diverse training backgrounds. Participants gave the workshop very positive course evaluations, and there was significant improvement in their confidence and knowledge. We believe this course material can easily be utilized at other institutions and can be modified to meet the specific needs of different audiences.

## Appendices

A. Small-Group Exercise and References.docx

B. Didactic Presentation.pptx

C. Workshop Agenda.docx

D. Preworkshop Survey.docx

E. Postworkshop Survey.docx

*All appendices are peer reviewed as integral parts of the Original Publication.*

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Smith CJ, Wardian J, Rohlfsen C, Sahak K. Teaching procedure skills: beyond "see one, do one, teach one." Abstract presented at: American College of Physicians Early Career Physician Research Competition; April 20, 2024; Boston, MA.

**Ethical Approval**
Reported as not applicable.

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