Incorporating Simulation Into Teaching

Leo Lamsen, MD

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Incorporating Simulation Into Teaching

- Problem identification and general needs assessment
- Needs assessment of targeted learners
- Goals and objectives
- Educational strategies
- Implementation
- Evaluation and feedback

Activity

- List an example for each of the following that you have thought about teaching and why you want to teach it.
  - Procedure
  - Medical problem
  - Difficult encounter

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Activity

Educational Program Planning: How To Effectively Deliver Information To Your Learners

G. Anthony Wilson, MD
William Dabbs, MD
Shauntá Chamberlin, PharmD

- Pick one and list 3 learning objectives that you want your learner to achieve

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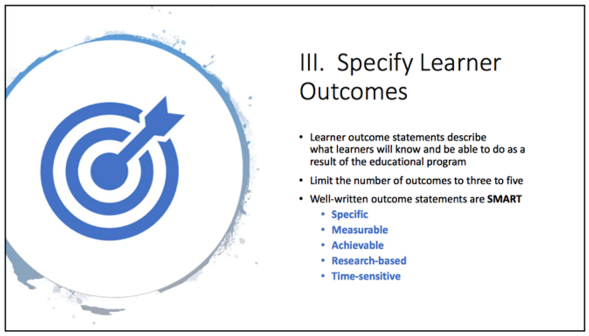
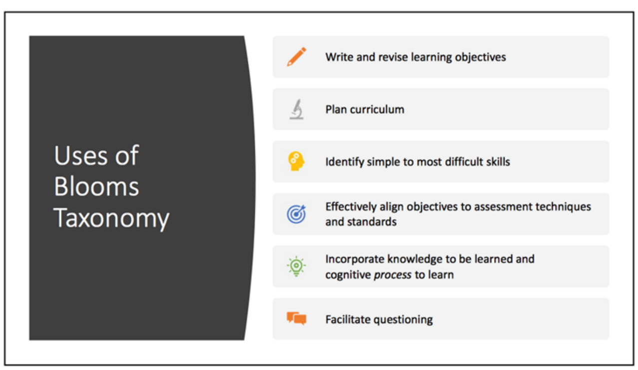
Activity



- Pick one and list 3 learning objectives that you want your learner to achieve

Activity



- Pick one and list 3 learning objectives that you want your learner to achieve

Objectives

- Define mastery learning
- Describe the differences between mastery learning and other traditional teaching methods
- Design a simulation-based mastery learning unit

Apprenticeship Model

See one → Do one → Teach one

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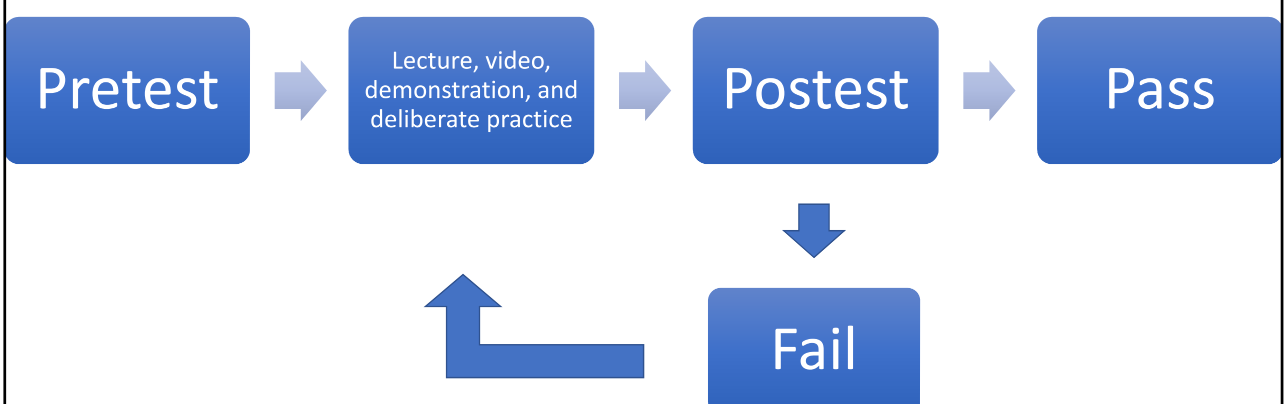
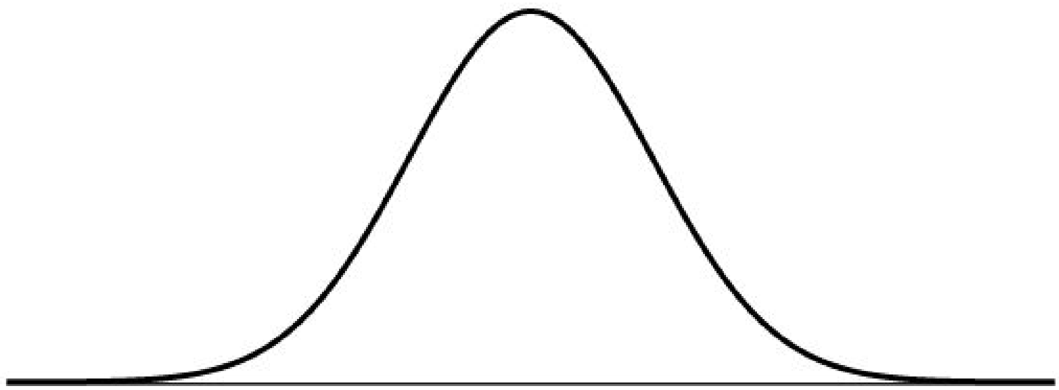
Most Simulation Interventions

Simulation-Based Mastery Learning





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Features of Mastery Learning

- Baseline, or diagnostic testing
- Clear learning objectives, sequenced as units usually in increasing difficulty
- Engagement in educational activities (eg, deliberate skills practice, calculations, data interpretation, reading) focused on reaching the objectives
- A set minimum passing standard (eg, test score) for each educational unit
- Formative testing to gauge unit completion at a preset minimum passing standard for mastery
- Advancement to the next educational unit given measured achievement at or above the mastery standard
- Continued practice or study on an educational unit until the mastery standard is reached

Acad Med. 2015;90:1438-1441

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Journal of HOSPITAL MEDICINE www.journalofhospitalmedicine.com
ORIGINAL RESEARCH

Use of Simulation-Based Mastery Learning to Improve the Quality of Central Venous Catheter Placement in a Medical Intensive Care Unit

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Elaine R. Cohen, BA[1]
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Supported by the Excellence in Academic Medicine Act of the Illinois Department of Public Aid, administered by Northwestern Memorial Hospital, and the Augusta Webster Research Award from Northwestern University Feinberg School of Medicine.

Disclosure: The authors have no financial or other potential conflicts of interest.

J. Hosp. Med. 2009 September;4(7):397-403

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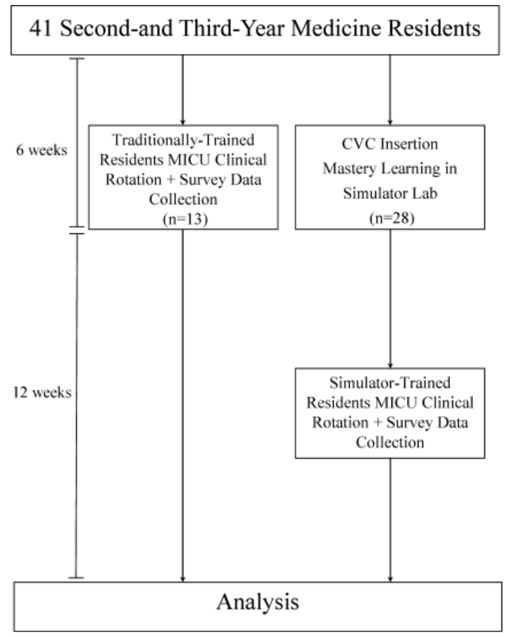

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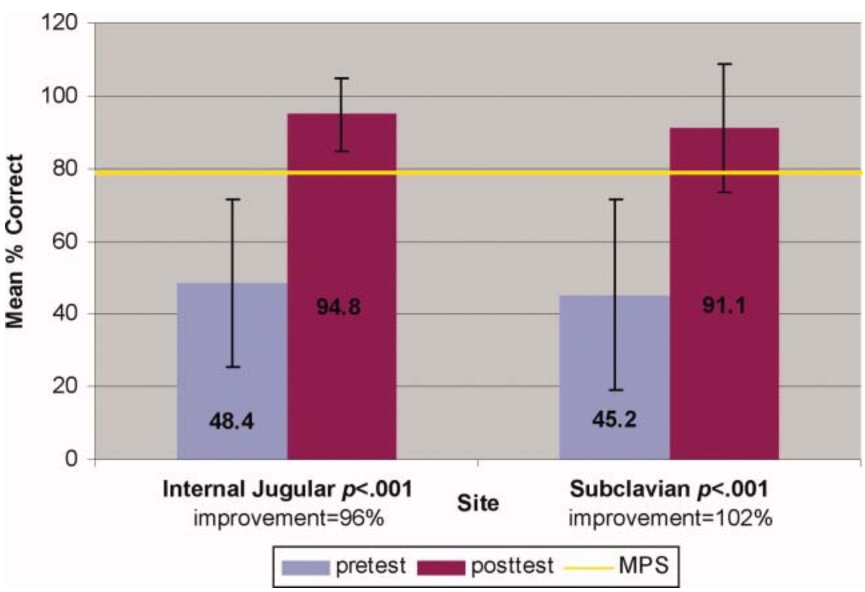

J. Hosp. Med. 2009 September;4(7):397-403

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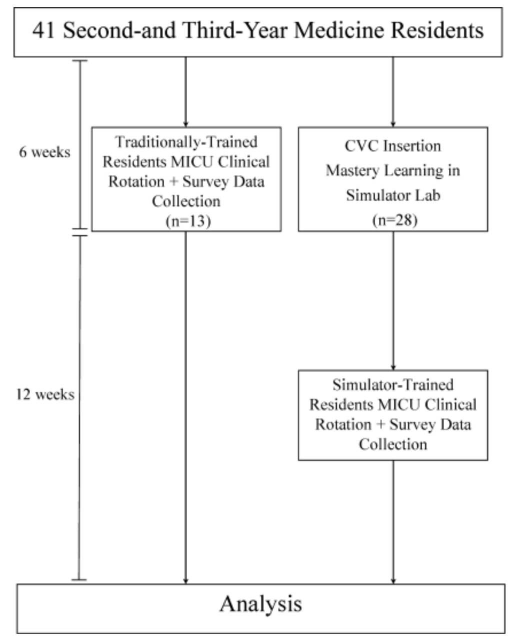

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Comparison of Traditionally Trained Residents vs. Simulator trained Residents in Self-confidence and CVC Quality Indicators During Actual CVC Insertions in the MICU

	Internal Jugular and Subclavian CVCs		
	Traditionally Trained Residents	**Simulator Trained Residents**	***P* value**
Number of attempts during insertion [mean (SD)]	2.78 (1.77)	1.79 (1.03)	0.04*
Pneumothorax (number)	0	0	n/a
Arterial puncture (%)	11	7	0.65
CVC adjustment (%)	15	8	0.52
Confidence (%) [mean (SD)]	68 (20)	81 (11)	0.02*

*
$p < 0.05$.

Abbreviations: CVC, central venous catheter; MICU, medical intensive care unit; n/a, not applicable.

J. Hosp. Med. 2009 September;4(7):397-403

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Simulation-based mastery learning reduces complications during central venous catheter insertion in a medical intensive care unit*

Jeffrey H. Barsuk, MD; William C. McGaghie, PhD; Elaine R. Cohen, BA; Kevin J. O'Leary, MD; Diane B. Wayne, MD

Objective: To determine the effect of a simulation-based mastery learning model on central venous catheter insertion skill and the prevalence of procedure-related complications in a medical intensive care unit over a 1-yr period.

Design: Observational cohort study of an educational intervention.

Setting: Tertiary-care urban teaching hospital.

Subjects: One hundred three internal medicine and emergency medicine residents.

Interventions: Twenty-seven residents were traditionally trained and did not receive simulation-based education. These residents were surveyed regarding complications and procedural self-confidence on actual central venous catheters they inserted in the medical intensive care unit. Subsequently, 76 residents completed simulation-based training in internal jugular and subclavian central venous catheter insertions. Simulator-trained residents were expected to meet or exceed a minimum passing score set by an expert panel and measured by performance on a skills checklist (given both before and after the educational intervention), using a central venous catheter simulator. Simulator-trained residents also took a written pre- and posttest. Simulator-trained residents were surveyed regarding complications and procedural self-confidence on actual central venous catheters they inserted in the medical intensive care unit.

Measurements and Main Results: Simulator-trained residents reported fewer needle passes ($p < .0005$), arterial punctures ($p < .0005$), catheter adjustments ($p = .002$), and higher success rates ($p = .005$) for actual central venous catheters inserted in the medical intensive care unit than traditionally trained residents. At clinical skills examination pretest, 12 (16%) of 76 simulator-trained residents met the minimum passing score for internal jugular central venous catheter insertion and 11 (14%) of 76 residents met the minimum passing score for subclavian central venous catheter insertion: mean (internal jugular) = 50.6%, SD = 23.4%; mean (subclavian) = 48.4%, SD = 26.8%. After simulation training, all residents met or exceeded the minimum passing score at posttest: mean (internal jugular) = 93.9%, SD = 10.2; mean (subclavian) = 91.5%, SD = 17.1 ($p < .0005$). Written examination performance improved from mean = 70.3%, SD = 7.7%, to 84.8%, SD = 4.8% ($p < .0005$).

Conclusions: A simulation-based mastery learning program increased residents' skills in simulated central venous catheter insertion and decreased complications related to central venous catheter insertions in actual patient care. (Crit Care Med 2009; 37:2697–2701)

KEY WORDS: central venous catheterization; medical education; anatomic model; complications; clinical competence; quality of health care

Crit Care Med. 2009;37(10):2697–2701.

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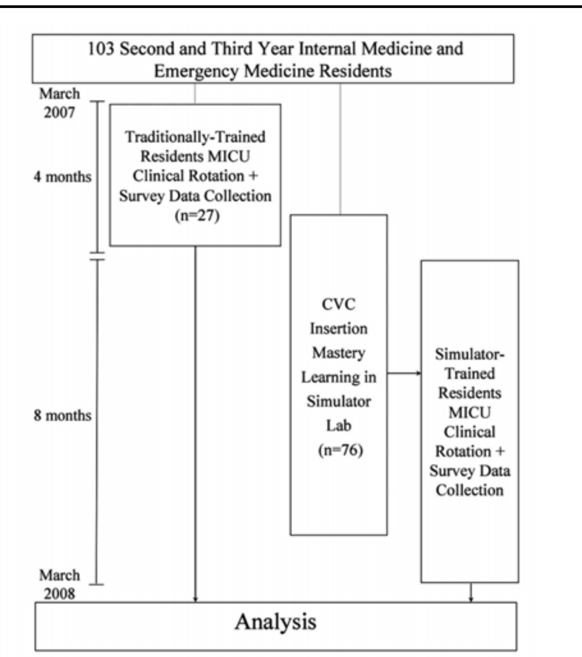

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	Subclavian CVCs, n = 19			Internal Jugular CVCs, n = 145			Total CVCs, n = 164		
	Traditionally Trained Residents	Simulator-Trained Residents	p	Traditionally Trained Residents	Simulator-Trained Residents	p	Traditionally Trained Residents	Simulator-Trained Residents	p
# of CVCs	11	8		31	114		42	122	
Mean (SD) # of CVC needle passes	2.09 (1.14)	2.38 (1.77)	.97	1.61 (.67)	1.25 (.71)	<.0005	1.74 (.83)	1.32 (.85)	<.0005
Arterial puncture (%)	1/11 (9%)	0/8 (0%)	.38	5/31 (16%)	1/114 (1%)	<.0005	6/42 (14%)	1/122 (1%)	<.0005
CVC adjustment (%)[a]	1/7 (14%)	1/5 (20%)	.79	6/27 (22%)	4/111 (4%)	.001	7/34 (21%)	5/116 (4%)	.002
Success rate (%)	7/11 (64%)	5/8 (63%)	.96	27/31 (87%)	111/114 (97%)	.018	34/42 (81%)	116/122 (95%)	.005
Pneumothorax (%)	0/11 (0%)	1/8 (13%)	.23	1/31 (3%)	1/114 (1%)	.32	1/42 (2%)	2/122 (2%)	.76

CVCs, central venous catheters.
CVC adjustment could not be measured if the insertion was not successful.

Crit Care Med. 2009;37(10):2697–2701.

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ORIGINAL INVESTIGATION

Use of Simulation-Based Education to Reduce Catheter-Related Bloodstream Infections

Jeffrey H. Barsuk, MD; Elaine R. Cohen, BA; Joe Feinglass, PhD; William C. McGaghie, PhD; Diane B. Wayne, MD

Background: Simulation-based education improves procedural competence in central venous catheter (CVC) insertion. The effect of simulation-based education in CVC insertion on the incidence of catheter-related bloodstream infection (CRBSI) is unknown. The aim of this study was to determine if simulation-based training in CVC insertion reduces CRBSI.

Methods: This was an observational education cohort study set in an adult intensive care unit (ICU) in an urban teaching hospital. Ninety-two internal medicine and emergency medicine residents completed a simulation-based mastery learning program in CVC insertion skills. Rates of CRBSI from CVCs inserted by residents in the ICU before and after the simulation-based educational intervention were compared over a 32-month period.

Results: There were fewer CRBSIs after the simulator-trained residents entered the intervention ICU (0.50 infections per 1000 catheter-days) compared with both the same unit prior to the intervention (3.20 per 1000 catheter-days) (*P*=.001) and with another ICU in the same hospital throughout the study period (5.03 per 1000 catheter-days) (*P*=.001).

Conclusions: An educational intervention in CVC insertion significantly improved patient outcomes. Simulation-based education is a valuable adjunct in residency education.

Arch Intern Med. 2009;169(15):1420-1423

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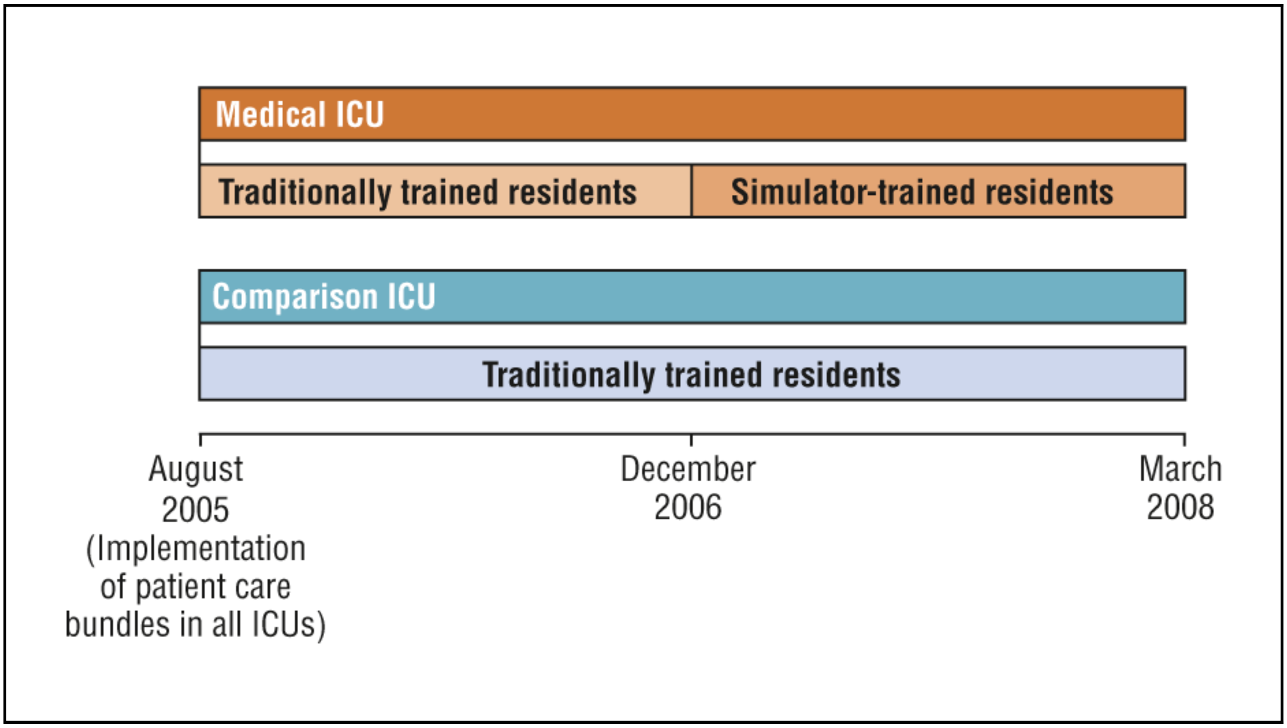
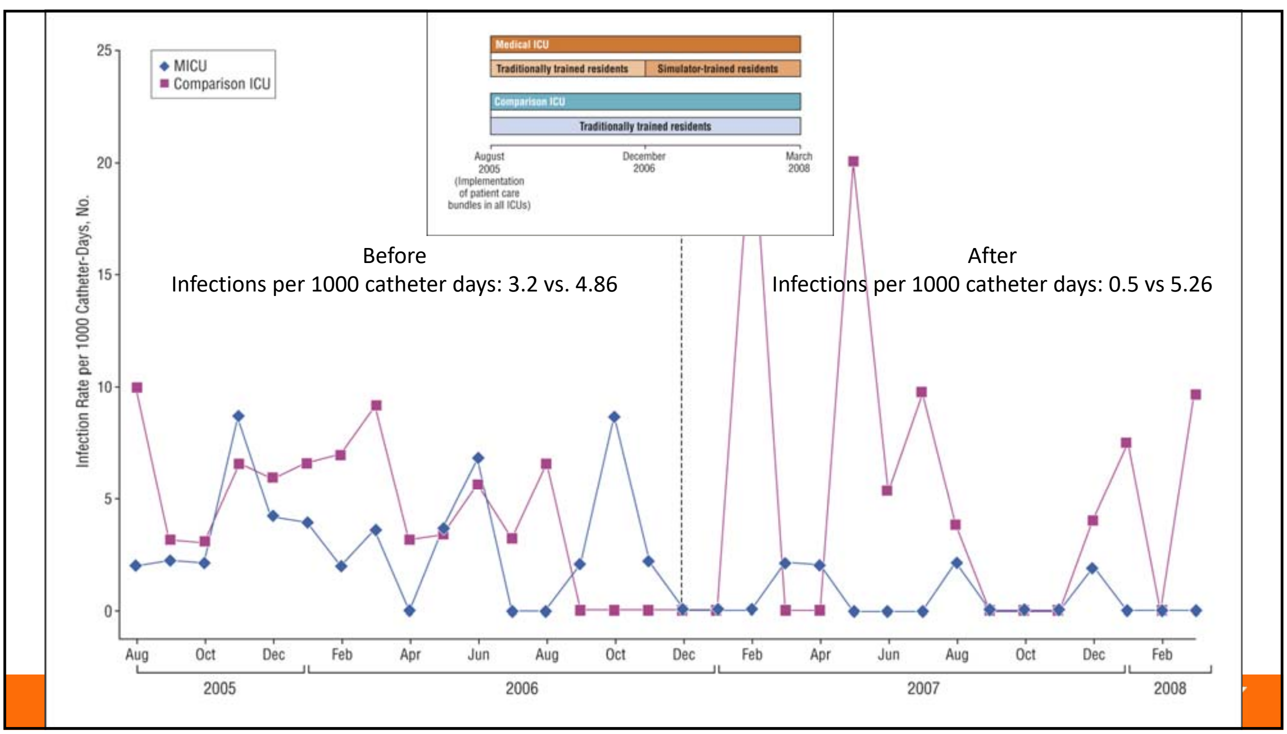

Medical ICU
Traditionally trained residents
Simulator-trained residents
Comparison ICU
Traditionally trained residents
August 2005 (Implementation of patient care bundles in all ICUs)
December 2006
March 2008


MICU
Comparison ICU
Infection Rate per 1000 Catheter-Days, No.
Before
Infections per 1000 catheter days: 3.2 vs. 4.86
After
Infections per 1000 catheter days: 0.5 vs 5.26
Aug Oct Dec Feb Apr Jun Aug Oct Dec Feb Apr Jun Aug Oct Dec Feb
2005
2006
2007
2008

Cost Savings From Reduced Catheter-Related Bloodstream Infection After Simulation-Based Education for Residents in a Medical Intensive Care Unit

Elaine R. Cohen, BA;
Joe Feinglass, PhD;
Jeffrey H. Barsuk, MD;
Cynthia Barnard, MBA, MSJS;
Anna O'Donnell, RN, BSN;
William C. McGaghie, PhD;
Diane B. Wayne, MD

Introduction: Interventions to reduce preventable complications such as catheter-related bloodstream infections (CRBSI) can also decrease hospital costs. However, little is known about the cost-effectiveness of simulation-based education. The aim of this study was to estimate hospital cost savings related to a reduction in CRBSI after simulation training for residents.
Methods: This was an intervention evaluation study estimating cost savings related to a simulation-based intervention in central venous catheter (CVC) insertion in the Medical Intensive Care Unit (MICU) at an urban teaching hospital. After residents completed a simulation-based mastery learning program in CVC insertion, CRBSI rates declined sharply. Case-control and regression analysis methods were used to estimate savings by comparing CRBSI rates in the year before and after the intervention. Annual savings from reduced CRBSIs were compared with the annual cost of simulation training.
Results: Approximately 9.95 CRBSIs were prevented among MICU patients with CVCs in the year after the intervention. Incremental costs attributed to each CRBSI were approximately $82,000 in 2008 dollars and 14 additional hospital days (including 12 MICU days). The annual cost of the simulation-based education was approximately $112,000. Net annual savings were thus greater than $700,000, a 7 to 1 rate of return on the simulation training intervention.
Conclusions: A simulation-based educational intervention in CVC insertion was highly cost-effective. These results suggest that investment in simulation training can produce significant medical care cost savings.
(*Sim Healthcare* 5:98–102, 2010)

Key Words: Simulation, Education, Cost-effectiveness, Infection, Intensive care unit.

9.95 CLABSIs prevented
X $82,0000 per CLABSI
= $815,900
- $112,000 to implement program
$703,900 annual savings

Simul Healthc. 2010 Apr;5(2):98-102

Long-Term Retention of Central Venous Catheter Insertion Skills After Simulation-Based Mastery Learning

Jeffrey H. Barsuk, Elaine R. Cohen, William C. McGaghie, and Diane B. Wayne

Abstract

Background
Simulation-based mastery learning (SBML) of central venous catheter (CVC) insertion improves trainee skill and patient care. How long skills are retained is unknown.

Method
This is a prospective cohort study. Subjects completed SBML and were required to meet or exceed a minimum passing score (MPS) for CVC insertion on a posttest. Skills were retested 6 and 12 months later and compared with posttest results to assess skill retention.

Results
Forty-nine of 61 (80.3%) subjects completed follow-up testing. Although performance declined from posttest where 100% met the MPS for CVC insertion, 82.4% to 87.1% of trainees passed the exam and maintained their high performance up to one year after training.

Conclusions
Skills acquired from SBML were substantially retained during one year. Individual performance cannot be predicted, so programs should use periodic testing and refresher training to ensure competence.

Acad Med. 2010 Oct;85(10 Suppl):S9-12.

Unexpected Collateral Effects of Simulation-Based Medical Education

Jeffrey H. Barsuk, MD, MS, Elaine R. Cohen, Joe Feinglass, PhD,
William C. McGaghie, PhD, and Diane B. Wayne, MD

Abstract

Purpose
Internal medicine residents who complete simulation-based education (SBE) in central venous catheter (CVC) insertion acquire improved skills that yield better patient care outcomes. The collateral effects of SBE on the skills of residents who have not yet experienced SBE are unknown.

Method
In this retrospective, observational study, the authors used a checklist to test the internal jugular and subclavian CVC insertion skills of 102 Northwestern University second- and third-year internal medicine residents before they received simulation training. The authors compared, across consecutive academic years (2007–2008, 2008–2009, 2009–2010), mean pretraining scores and the percent of trainees who met or surpassed a minimum passing score (MPS).

Results
Mean internal jugular pretest scores improved from 46.7% (standard deviation = 20.8%) in 2007 to 55.7% (±22.5%) in 2008 and 70.8% (±22.4%) in 2009 ($P < .001$). Mean subclavian pretest scores changed from 48.3% (±25.5%) in 2007 to 45.6% (±31.0%) in 2008 and 63.6% (±27.3%) in 2009 ($P = .04$). The percentage of residents who met or surpassed the MPS before training for internal jugular insertion was 7% in 2007, 16% in 2008, and 38% in 2009 ($P = .004$); for subclavian insertion, the percentage was 11% in 2007, 19% in 2008, and 38% in 2009 ($P = .028$).

Conclusions
SBE for senior residents had an effect on junior trainees, as evidenced by pretraining CVC insertion skill improvement across three consecutive years. SBE for a targeted group of residents has implications for skill acquisition among other trainees.

Acad Med. 2011 Dec;86(12):1513-7

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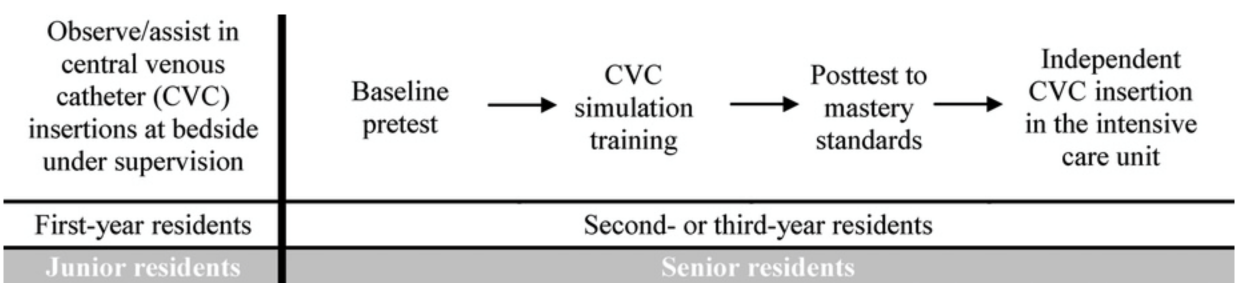

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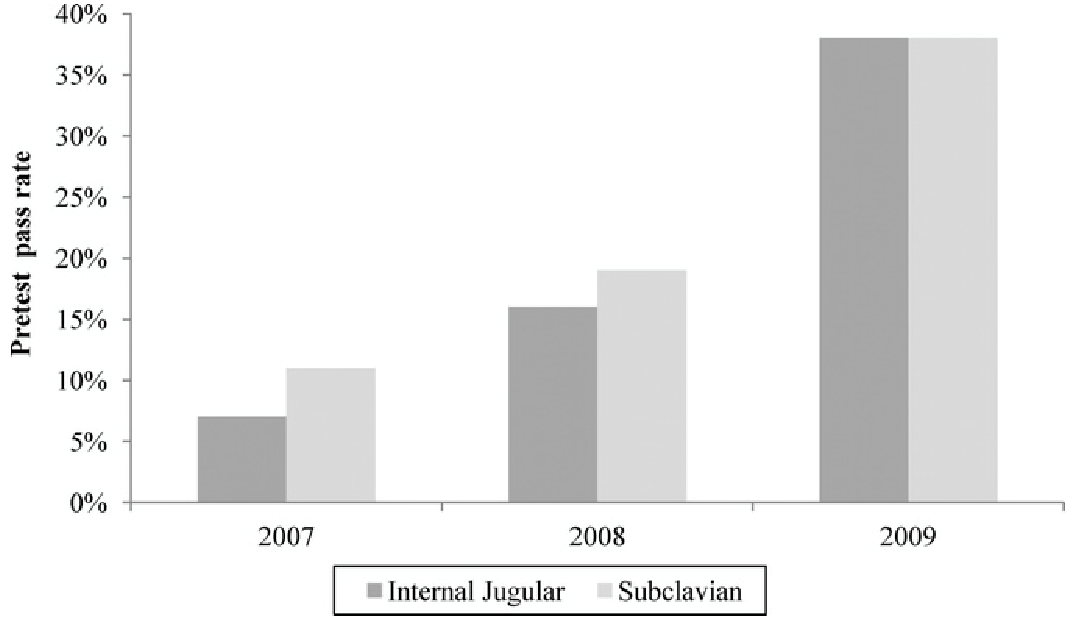
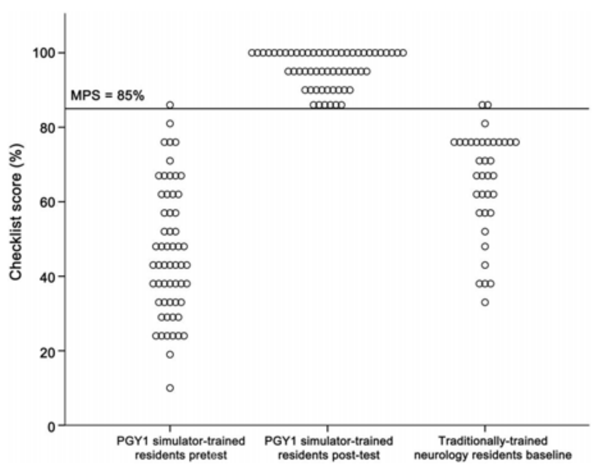
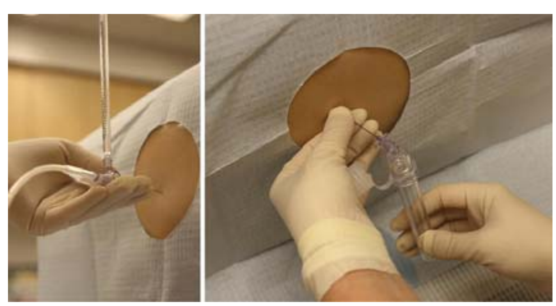


Acad Med. 2011 Dec;86(12):1513-7

Simulation-based education with mastery learning improves residents' lumbar puncture skills





Neurology 2012;79:132–137

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J Pain Symptom Manage. 2019 Mar;57(3):682-687. doi: 10.1016/j.jpainsymman.2018.11.012. Epub 2018 Nov 23.

Development of a Simulation-Based Mastery Learning Curriculum for Breaking Bad News.

Vermylen JH[1], Wood GJ[2], Cohen ER[2], Barsuk JH[3], McGaghie WC[4], Wayne DB[3].

⊕ **Author information**

Abstract

INTRODUCTION: Physician communication impacts patient outcomes. However, communication skills, especially around difficult conversations, remain suboptimal, and there is no clear way to determine the validity of entrustment decisions. The aims of this study were to 1) describe the development of a simulation-based mastery learning (SBML) curriculum for breaking bad news (BBN) conversation skills and 2) set a defensible minimum passing standard (MPS) to ensure uniform skill acquisition among learners.

INNOVATION: An SBML BBN curriculum was developed for fourth-year medical students. An assessment tool was created to evaluate the acquisition of skills involved in a BBN conversation. Pilot testing was completed to confirm improvement in skill acquisition and set the MPS.

OUTCOMES: A BBN assessment tool containing a 15-item checklist and six scaled items was developed. Students' checklist performance improved significantly at post-test compared to baseline (mean 65.33%, SD = 12.09% vs mean 88.67%, SD = 9.45%, $P < 0.001$). Students were also significantly more likely to have at least a score of 4 (on a five-point scale) for the six scaled questions at post-test. The MPS was set at 80%, requiring a score of 12 items on the checklist and at least 4 of 5 for each scaled item. Using the MPS, 30% of students would require additional training after post-testing.

COMMENTS: We developed a SBML curriculum with a comprehensive assessment of BBN skills and a defensible competency standard. Future efforts will expand the mastery model to larger cohorts and assess the impact of rigorous education on patient care outcomes.

Acta Anaesthesiol Scand. 2018 Jul;62(6):811-819. doi: 10.1111/aas.13083. Epub 2018 Feb 1.

Simulation-based point-of-care ultrasound training: a matter of competency rather than volume.

Jensen JK[1], Dyre L[2,3], Jørgensen ME[4], Andreasen LA[2], Tolsgaard MG[2,3].

⊕ **Author information**

Abstract

BACKGROUND: Point-of-care ultrasonography plays an increasingly important role in the initial resuscitation of critically ill patients but acquisition of the skill is associated with long learning curves. The skills required to perform ultrasound examinations can be practiced in a simulated setting before being performed on actual patients. The aim of this study was to investigate the learning curves for novices training the FAST protocol on a virtual-reality simulator.

METHODS: Ultrasound novices (N = 25) were instructed to complete a FAST training program on a virtual-reality ultrasound simulator. Participants were instructed to continue training until they reached a previously established mastery learning level, which corresponds to the performance level of a group of ultrasound experts. Performance scores and time used during each FAST examination were used to determine participants' learning curves.

RESULTS: The participants attained the mastery learning level within a median of three (range two to four) attempts corresponding to a median of 1 h 46 min (range 1 h 2 min to 3 h 37 min) of simulation training. The ultrasound novices' examination speed improved significantly with training, and continued to improve even after they attained the mastery learning level ($P = 0.011$). Twenty-three participants attained the mastery learning level.

CONCLUSION: Novices can attain mastery learning levels using simulation-based ultrasound training with less than, on average, 2 h of practice. However, we found large variations in the amount of training needed, which raises questions about the adequacy of current volume-based models for determining ultrasound competency.

J Grad Med Educ. 2015 Jun;7(2):181-6. doi: 10.4300/JGME-D-14-00516.1.

Mastery of Status Epilepticus Management via Simulation-Based Learning for Pediatrics Residents.

Malakooti MR, McBride ME, Mobley B, Goldstein JL, Adler MD, McGaghie WC.

Abstract

BACKGROUND: Management of status epilepticus (SE) in the pediatric population is highly time-sensitive. Failure to follow a standard management algorithm may be due to ineffective provider education, and can lead to unfavorable outcomes.

OBJECTIVE: To design a learning module using high-fidelity simulation technology to teach mastery achievement of a hospital algorithm for managing SE.

METHODS: Thirty pediatrics interns were enrolled. Using the Angoff method, an expert panel developed the minimal passing score, which defined mastery. Scoring of simulated performance was done by 2 observers. Sessions were digitally recorded. After the pretest, participants were debriefed on the algorithm and required to repeat the simulation. If mastery (minimal passing score) was not achieved, debriefing and the simulation were repeated until mastery was met. Once mastery was met, participants graded their comfort level in managing SE.

RESULTS: No participants achieved mastery at pretest. After debriefing and deliberate simulator training, all (n=30) achieved mastery of the algorithm: 30% achieved mastery after 1 posttest, 63% after a second, and 6.7% after a third. The Krippendorff α was 0.94, indicating strong interrater agreement. Participants reported more self-efficacy in managing SE, a preference for simulation-based education for learning practice-based algorithms of critical conditions, and highly rated the educational intervention.

CONCLUSIONS: A simulation-based mastery learning program using deliberate practice dramatically improves pediatrics residents' execution of a SE management protocol. Participants enjoyed and benefited from simulation education. Future applications include improving adherence to other hospital protocols.

AHA SCIENTIFIC STATEMENT

Resuscitation Education Science: Educational Strategies to Improve Outcomes From Cardiac Arrest

A Scientific Statement From the American Heart Association

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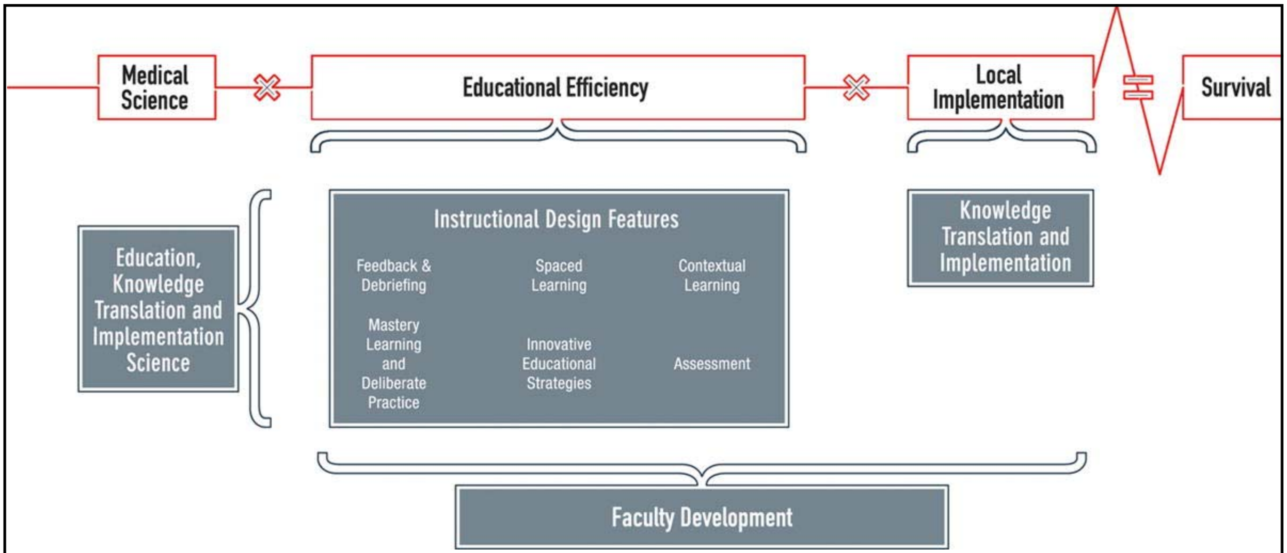

Circulation. 2018 Aug 7;138(6):e82-e122.

Question #1

Mastery learning

a) Results in varying outcomes in the same amount of time
b) Is a technique taught to medical students and residents on how to learn more efficiently
c) Establishes a level of performance that all learners must master before moving onto the next unit
d) Cannot be achieved until the learner has met all the prerequisites

Question #2

The role of the pretest in a mastery learning program is to:

a) Establish a baseline of each learner's achievement status
b) Show each learner how poor his/her achievement status really is
c) Weed out learners who are not prepared to receive instruction
d) Identify persons who should pursue a different career path

Question #3

The purpose of summative evaluation in a mastery learning program is to provide learners with data about:

a) Achievement that meets or exceeds the minimum passing standard
b) One's readiness for independent, unsupervised clinical practice
c) How each student compares with his/her peers
d) How each student compares to historical student cohorts

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Question #4

Mastery learning can be used in health professions education to help learners acquire skills in:

a) Communication with patients and their families
b) Clinical procedures such as lumbar puncture, thoracentesis, and suturing
c) Clinical management of status epilepticus
d) All of the above

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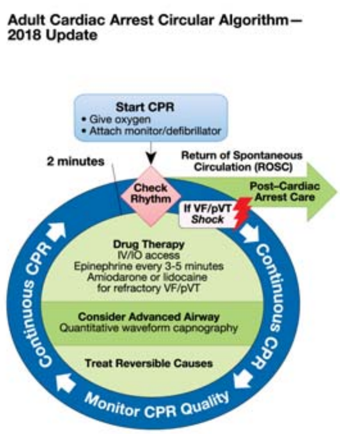
Activity



- Create a checklist that encompasses the procedure, medical problem, or difficult situation that you would like to teach.

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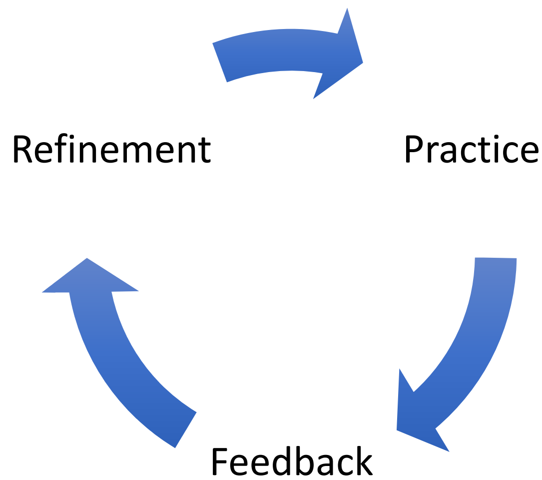
Design a Simulation-Based Mastery Learning Unit

- Problem identification and general needs assessment
- Needs assessment of targeted learners
- Goals and objectives
- Educational strategies
- Implementation
- Evaluation and feedback

Mastery Learning Deliberate Practice

Deliberate Practice

- Motivated learners
- Identify well-defined task
- Focused, repetitive practice
- Ample opportunity to practice
- Informative feedback
- Opportunity to correct errors
- Goal: skill improvement



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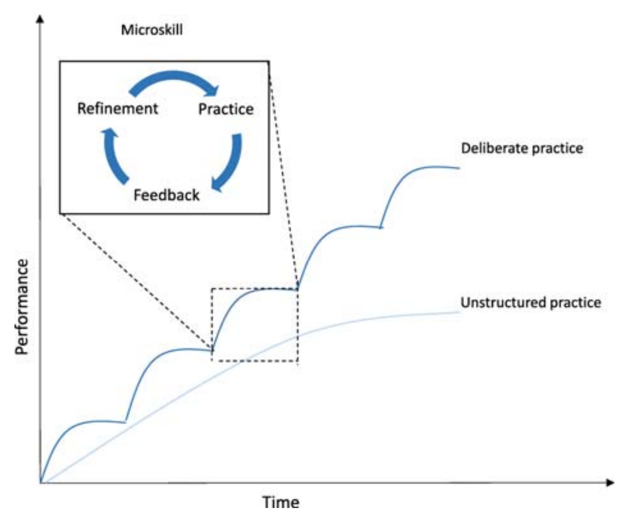
Deliberate Practice Model



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Standards Setting

- Traditional
  - MPS set at the level of minimum competency
- Mastery learning
  - MPS set at a level where the learners are well prepared for the next stage of training or practice

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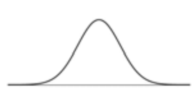
Standards

Normative

- Requiring a score above 1.5 SDs below the mean examination score
- Relative to the performance of the group
- Have no place in mastery settings



Absolute

- Criterion-based
- Independent of the group taking the test
- Relative to an external standard
- Ex: 80% correct
- Appropriate for competency-based curricula

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Standards Setting

- Angoff
  - Judges are asked to predict the performance of the "boderline student" who is at the edge of minimal competence
  - Does not distinguish between critical and noncritical items
- Hofstee
  - Judges are asked to specify the minimum and maximum acceptable passing scores and failure rates.
  - Consideration for an acceptable failure rate

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Incorporating Simulation Into Teaching

Leo Lamsen, MD

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Summary

- Mastery learning is an instructional approach in which educational progress is based on demonstrated performance, not curricular time.
- Learners practice and retest repeatedly until they reach a designated mastery level.
- The final level of achievement is the same for all, although time to mastery may vary

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