Time-efficient, goal-directed, and evidence-based teaching in the ICU

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Purpose of review
Teaching in the stressful, high-acuity environment of the ICU is challenging. The intensivist-educator must use teaching strategies that are both effective and time-efficient, as well as evidence-based approaches to the ICU curriculum. This review provides an overview of pertinent educational theories and their implications on educational practices, a selection of effective teaching techniques, and a review on feedback.

Recent findings
Evidence supports the role of conceptual frameworks in providing the educator with a key perspective to obtain a deeper understanding of the factors contributing to an effective and goal-directed education in the ICU. The role of simulation training for technical and nontechnical skills acquisition is growing. Feedback is difficult to provide, but critical to facilitate learner success; frameworks, and approaches are becoming more standardized.

Summary
Direct teaching should be goal-oriented, sequential, and adjusted to the level of the learner. The ICU curriculum should optimize cognitive load, reduce stress that is unrelated to the activity, include resilience training, and help trainees deal with stressful clinical situations better. Simulation is a powerful tool to promote technical and nontechnical skills. Providing feedback is essential and a skill that can be taught and enhanced with structure, prompts, and tools.

Keywords
curriculum, education, feedback, intensive care, simulation, teaching

INTRODUCTION

It is challenging for faculty to provide effective teaching in the ICU [1,2]. Although the reasons are multifactorial and variable, three reasons deserve particular attention: limited theoretical knowledge by faculty on how trainees learn, lack of familiarity with effective and efficient teaching strategies, and difficulty providing effective feedback [1,3,4,5▪,6▪▪,7,8▪▪]. It is assumed that every physician is a competent teacher upon graduation from medical school. However, about 90% of all anesthesia residency program directors believe their faculty needs help providing competent feedback, with less than 50% of all surveyed anesthesia programs having resources to address this issue [4]. Given the lack of educational foundation, growing clinical demands, and fear of negative evaluations, there is a danger that teaching may become a popularity contest instead of an evidence-based, goal-directed effort.

In this review, we provide a pragmatic overview of pertinent educational theories and their implications, a selection of effective teaching techniques, and a review of feedback.

RELEVANT EDUCATIONAL THEORIES AND MODELS

Four educational models provide insight into the learning process [9–14]. Implications for teaching and goal-directed curricular design are presented in Tables 1 and 2.

Self-Directed Learning is based on the concept of a self-directed and autonomous adult learner [12,13,15–18]. The teacher becomes the coach and focuses on facilitating learning instead of teaching. Learning should be centered on past experiences, kept clinically relevant and practical, encourage

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KEY POINTS

- Effective faculty training is critical to ensure high-quality teaching and feedback (i.e. 'teach-the-teacher'/faculty development resources).
- Conceptual frameworks facilitate an evidenced-based understanding of the factors contributing to an effective and goal-directed education in the ICU.
- The intensivist should be familiar with teaching techniques that are brief, simple, and effective, as well as promoting goal-directed teaching.
- In-situ simulation is a powerful tool to promote technical and nontechnical skills.
- Feedback should be timely, detailed, specific, constructive, and nonjudgmental. Faculty training, allocation of specific time, use of prompts and reminders, and multiple sources all contribute to enhancing feedback quality and utility.

independent learning, and be conducted respectfully.

Dreyfus and Dreyfus Model (DDM) describes skill acquisition [9,11,19–21]. In the DDM, progression from novice learner to master clinician is nonlinear. Instead, skills and expertise develop in six stages of increasing complexity (Table 3). For example, an intern (novice) with limited experience approaches a clinical problem with an analytical, text-book, and rule-based mindset, free of clinical context. As the learner progresses through training and is exposed to more clinical situations, they

(1) appreciate that most clinical scenarios are 'copies' of previous patients that can be safely and quickly addressed using pattern-recognition,
(2) learn to prioritize, and
(3) develop their own (idiosyncratic) preferences.

Some, use the analogy of a dancer to describe the DDM, where the beginner consciously repeats 'left foot, right foot' using a rule-based approach of a 'textbook'; an intermediate dancer only monitors the difficult steps; an expert dancer can dance intuitively and on 'autopilot.' Each dancer uses their own unique steps and moves to express the music [1].

Cognitive Load Theory (CLT) proposes that learning new information requires cognitive processing capacity, and if this requirement surpasses

Table 1. The four pertinent educational theories and their implications on direct teaching

Educational models	Key implications for direct teaching/lectures [1,3,6▪▪,7,8▪▪]
Self-directed learning	The learner is the driving force of the learning process. Consequently, the teacher becomes the coach: Facilitate learning by directing the learner to educational materials and encouraging self-directed study. Center teaching on the learner's past experiences, keep it clinically relevant and focused on the patient at hand, demonstrate the relevance of the knowledge. Treat the learner as a colleague.
Dreyfus and Dreyfus [9,11,19,85]	The *Novice learner* is focused on pathophysiology, has little ability to filter/prioritize, and prefers consistency. Teaching should use 'textbook'-language, avoid cognitive overload by offering rules and protocols and limiting the number of techniques. The *Advanced learner* is able to filter/prioritize and is invested in expanding their portfolio of technical and clinical skills. Teaching should focus on advanced skills: clinical judgment, variety of approaches, intuitive, pattern-based decision making, concise patient presentation focused on pertinent data; taking the learner beyond 'comfort zone' is key at this stage.
Cognitive Load Theory [10,27▪,31▪]	Teacher should avoid cognitive overload of the learner Break up complex materials into smaller, easier to 'digest' sections. Use the least complex approach to convey novel information. For example: chest X-ray with pneumonia-related changes will convey the information quicker, clearer, and with less cognitive load than describing the changes verbally. Avoid redundant information. For example: Slides that do not match the verbal information can be confusing to the learner and possibly distract with nonessential information (Redundancy Effect). Ensure information is provided in an integrated way, as a need to divide attention between two or more sources of information can reduce trainees' learning (Split-attention Effect).
Cognitive Appraisal Theory of Stress [33]	Teacher should be cognizant of stress Reduce all forms of stress not beneficial to learning, such as social stress, anticipatory stress, stress caused by lack of well defined goals, objectives, expectations, roles in the team, etc. Include elements focused on helping trainees become more stress-resilient and function better when faced with stressful clinical situations. Encourage the learner to see the clinical problem as a challenge and not as stress or threat.

Table 2. The implications of the four pertinent educational theories on goal-directed curricular design

Educational models	Implications for curricular design [1,3,6▪▪,7,8▪▪]
Self-Directed Learning [16,18]	The curricular elements should Encourage self-directed study and compensate for a wide range of clinical experiences, preexistent skills, and talent. For example, 'Flipped classroom' could provide 'core' and 'advanced' materials with in-person lectures, deepening the understanding and motivating the learner; incentives, like tests, can increase the motivation. Keep it practical and focused on the ICU patients and ICU team. For example, the simulation scenarios should be as 'realistic as possible,' using common ICU scenarios, and in-situ design (team/location) The learner should participate in the development of the ICU curriculum.
Dreyfus and Dreyfus [1,3,20]	The curricular elements should compensate for a wide range of clinical experiences and preexistent skills, allowing for development of skills depending on the level of the learner. For example, simulation session should emphasize checklists in the beginner, while encouraging deeper thinking in the advanced learner. The expectations regarding patient presentations during ICU rounds should reflect the level of the learner: interns typically present all patient data, with little synthesis and translation to overall clinical picture. The more advanced residents should be expected to effectively summarize the pertinent clinical data and present the hallmark signs of the condition.
Cognitive Load Theory [22–25,27▪,28–30]	The curricular elements should avoid cognitive overload using a learner-adjusted sequential approach and clearly define the objectives, roles, and expectations. Activity with low cognitive load could be perceived as not stimulating and of low educational value by an experienced trainee. Break up complex materials into smaller, easier to 'digest' sections. For example, an introductory syllabus or 'flipped classroom' prior to ICU rotation can effectively reduce the intrinsic load (pretraining effect). Educational materials, lectures, curricula, and so forth, should be learner-adjusted and designed to make learning easier. For example: segment teaching of clinical skills, e.g., when introducing new skill, start with a low-fidelity setup (e.g. pillow for central line placement) before moving to a high-fidelity situation (patient). Include potential solutions when preparing instructional materials on clinically challenging problems (worked example effect). Materials designed for beginners may be neutral/detrimental to an advanced learner. For example: '*The simulation scenario was not realistic. It didn't reflect our ICU,' or 'Information during a code is never presented that way.'* (*Expertise reversal effect*).
Cognitive Appraisal Theory of Stress [10,14,33–35,84]	Reduce stress by defining rotation specific objectives, goals, and expectations; stress unrelated to the activity, such as noise, or inconsistent 'rules' during simulation requiring continuous adjustment; social stress, through team-building activities and team dynamics training. Include stress resilience training and how to deal with stressful situations: when introducing stress training use skills learner is already familiar with (overlearning); consider stress inoculation training.

the learner's available working memory, learning is impaired [7,10,22,23,24▪,25,26,27▪,28–30,31▪]. There are three types of cognitive load [10,24▪]:

(1) Intrinsic cognitive load (ICL) represents the inherent level of difficulty of a specific topic (e.g. sepsis). Although it cannot be changed ('*sepsis*' cannot be made less complex), breaking the topic down into smaller components and teaching them sequentially decreases ICL.
(2) Extraneous cognitive load represents the manner in which new information is presented to the trainee. It is controlled by the teacher through curriculum design and teaching.
(3) Germane cognitive load (GCL) represents cognitive load beneficial to learning. For example, introducing variability in practice, while representing an additional load, can promote flexibility in the advanced learner. However, GCL may have negative effects in the beginner still trying to master the simple scenario.

Cognitive Appraisal Theory of Stress (CATS) argues that learner's personal interpretation of an event determines their emotional reaction [14,32]. This involves two steps: step 1, primary appraisal assesses whether the event is beneficial or harmful based on individual motivations. For example, cancellation of a simulation session could be perceived as *'Great! I can leave earlier' vs. 'I want the practice'*; step 2: secondary appraisal examines the present resources to manage the event. For example, emergent intubation could be perceived in different ways: *'I've got this!' vs. 'I will fail and seem incompetent' vs. 'No difficult-airway-cart. What do I do now?' vs. 'Great, I have everything I need.'* The appraisal determines whether the situation is perceived as a 'negative threat' or as a 'positive challenge' that can be solved.

Table 3. Dreyfus and Dreyfus Model: stages of learning development

Stage	Development Issues	Training level
Novice	Limited clinical ICU experience Uses analytical, textbook approach Has difficulty prioritizing clinical information May not feel personally responsible for patient care	Intern or medical student presenting granular details of a case without recognition of an overarching picture
Advanced Beginner	Appreciates recurrent clinical presentations Starts to manage clinical situations without 'textbook' using 'pattern-recognition approach' Starts to prioritize Develops own (idiosyncratic) clinical preferences	Junior resident able to summarize the granular data into hallmark signs of the condition
Competent	Uses pattern-recognition, yet applies analytical thinking in complex scenarios Develops a wide range of approaches Takes responsibility for clinical decision-making Appreciates the consequences of clinical decisions May stay longer to follow-up on the progress of the patient	Senior resident with ability for early recognition of the pattern of symptoms
Proficient learner	Strong intuitive sense Capable of handling dynamic and evolving situations. Appreciates own limitations Requires autonomy; resource availability when needed	Fellow or junior attending able to manage evolving advanced and complex clinical presentations
Expert learner	Utilizes pattern-recognition/'autopilot' routinely Identifies presentations requiring further analysis Self-reflection and continued review of clinical decisions enables change in practice Committed to lifelong learning	Mid-level attending
Master learner	Applies self-reflection Reflects on individual patient cases Tries to improve clinical practice in the field	Senior attending

See text. Adapted from Bhave and Brzezinski [1].

In this context, we should consider the impact of stress on performance:

(1) Stress is highly subjective, preventing reliable prediction of stressors and their effects on clinical performance [33]. For example, acute stress negatively impacted paramedics' clinical performance [34]. Yet, in residents who perceived all scenarios as being highly stressful *irrespective* of the presence of stressors, an addition of acute stressors failed to impact clinical performance [35]. In fact, perceived stress started before the activity (anticipatory stress) and likely originated in concerns regarding judgment by other team members (social evaluative stress) [35].
(2) Elevated stress levels [33,35,36]
   (a) Negatively affect memory retrieval and working memory. For example, 'During the code, I had difficulty remembering simple facts and calculating medication doses'.
   (b) Enhance memory consolidation, as long as the stress is related to the activity, for example, 'I remember the simulation scenario' vs. 'I remember a malfunctioning mannequin.'

SIMPLE, EFFECTIVE, TIME-EFFICIENT, AND GOAL-DIRECTED TEACHING TECHNIQUES

Teaching during ICU rounds should be goal-directed and time-efficient [1,3,37▪▪,38]:

(1) Determine trainee learning needs thorough observations and questions,
(2) Limit teaching to identified needs only, and,
(3) Provide feedback on learner's strengths as well as recommendations for improvement.

This approach saves time by limiting the scope to *what is needed*, and not teaching what the learner already knows, or is not ready for [1,38]. There are five goal-directed techniques the intensivist should be familiar with that are brief, simple, and highly effective for impromptu or bedside teaching [1,3,37▪▪,38].

(1) One-Minute Preceptor Model (1-MPM) is the most researched and established teaching model [39–41]. 1-MPM has been found to improve faculty teaching skills, increasing both faculty and learner satisfaction [39–49]. It emphasizes clinical reasoning as well as higher order thinking and consists of four steps:

(a) Obtain a commitment from the learner on a clinical problem. For example, the faculty asks the learner '*What do you think is going on/What is the diagnosis?*'
(b) Probe for supporting evidence and clinical reasoning. For example, '*What would you like to do now for this patient?*' or '*What led you to that conclusion?*'
(c) On the basis of identified strengths and needs, teach a general principle, provide rules of thumb, and impart clinical pearls.
(d) Provide feedback.

(2) The Aunt Minnie Model (AMM) effectively teaches rapid pattern recognition [37▪▪,38,50,51]. Established by a radiologist, it is based on the premise that '*a case with radiologic findings so specific and compelling that no realistic differential diagnosis exists*'. For example, the teacher points to an image (e.g. pneumothorax on X-Ray), an ECG (acute MI), and so forth, and ask '*What is the diagnosis?*' Recently, the AMM was used to promote diagnostic accuracy in an outpatient setting; learners were asked to provide the chief complaint and the presumptive diagnosis of the clinical presentation [50,52]. Consequently, AMM could promote diagnostic accuracy in an ICU setting.
(3) The Think Aloud Approach (TAA) is a powerful tool to teach clinical reasoning [3,53,54]. In TAA, the intensivist describes aloud, step by step, to the learner(s) what they were thinking when making a particular clinical decision. For example, *'The code was very demanding and my decisions may not have been clear to everyone – why don't I explain what was going on in my head.'*
(4) SPIT technique broadens differential diagnosis by encouraging the learner to identify diagnoses that are Serious, Probable, Interesting, or Treatable (SPIT); setting the stage for engaging discussions that promote learning, especially in the advanced learner. SPIT has also been used to identify the 'worst' diagnosis, while remaining aware of uncommon diagnoses [37▪▪].
(5) 'Activated' Demonstration Model has been found to promote technical skills in diverse clinical setups [38,55–63]. Here, the educator demonstrates to the learner how to perform a skill effectively: inform the trainee what to focus on, that is, the key teaching point, after the demonstration, '*activate*' the learner by asking them to describe what they observed, verifying the teaching point, ask the trainee to perform the procedure to reemphasize the teaching point, and provide feedback. The 'Activated' Demonstration Model can be equally effective in the promotion of nontechnical skills, such as difficult conversations during ICU family meetings or disclosure of medical errors (e.g. '*Please observe me during the family meeting*').

CURRICULAR DESIGN: TRANSFER OF KNOWLEDGE, TECHNICAL, AND NONTECHNICAL SKILLS

It is important for faculty to be familiar with learning theories to optimize curricular design, including the development of effective educational materials and simulation sessions (Table 2) [1,3,7,8▪▪]. Conceptual frameworks facilitate an evidenced-based understanding of the factors, contributing to an effective and goal-directed education in the ICU [1,3,6▪▪,7,8▪▪].

Here is a selection of simple, easily implementable, and evidence-based curricular interventions:

Introductory curriculum

Providing introductory materials to trainees prior to the rotation is a crucial step to reduce stress and cognitive overload [1,3,6▪▪,7,8▪▪,10,27▪,28]. They can be delivered as handouts, online modules, or even classroom and simulator-based learning sessions [64,65▪]. They should cover a wide range of topics, including:

(1) Goals and objectives relevant to the learner, for example, knowledge, skill acquisition, graduated autonomy, leadership, and communication
(2) Expectations in regard to knowledge, technical skills, presentation style, and feedback
(3) Description of the roles and responsibilities
(4) ICU-specific knowledge using materials that provide the *minimum* amount of knowledge required to start the ICU rotation safely, in addition to links providing advanced resources [1]. This increases the likelihood residents will read the materials. It also increases satisfaction and motivation to learn more, all the while reducing the anticipatory stress.

First day of the ICU rotation

ICU teams represent a diverse group of people (multidepartmental and multiprofessional) and with varying levels of clinical experience [1,3,6▪▪,7,8▪▪,66,67]. This creates a wide range of learner expectations. Thus, it is essential to establish clear expectations for knowledge, technical skills, presentation style, and feedback. Equally important, unrealistic expectations from the learner and

teacher need to be removed [1]. A clear description of the responsibilities for each team member (clinical and educational) encourages team bonding, prevents frustration, and optimizes teaching.

Classroom daily lectures on fundamental ICU topics

Factors essential for success include consistency, accessible educational materials, segmented information, and relevant topics, along with feedback and follow-up [1,3,6▪▪,7,8▪▪]. The topics should build upon each other to facilitate learning, with complex topics subdivided and adjusted to the level of the learner. The lecture should be limited to 30 min to accommodate for delays, maintain focus, and provide time for discussion.

The 'Flipped Classroom' has been found to be an effective model in improving educational efficiency across a range of learners in a variety of clinical settings, including ICU [65▪,68]. It emphasizes active learning, higher order thinking, and interactive discussion. Educational resources should consist of 'core' and 'advanced' materials. To incentivize routine preparatory reading and assess the learner's baseline, lectures should start with a quiz.

In-person lectures should come from experienced faculty, emphasize learner-centric activities, and offer a 'big picture' takeaway with implementable clinical pearls, providing a motivational boost. Talks by inexperienced speakers may be hindered by redundant and busy slides, poor integration of verbal and written information, as well as lack of pragmatic clinical perspective. Involvement of experts from other specialties has the additional benefit of improving communication between teams.

ICU rounds teaching

(1) Impromptu sessions are flexible educational activities in response to issues identified during ICU rounds; they should be focused, cover one to two teaching points, and relate to the patient at hand. If possible, further reading suggestions should be provided [1].
(2) Bedside teaching is a key educational tool promoting bedside manners, patient–doctor communication, the importance of a physical exam, as well as role-modeling. Teacher preparation is key: limit the number of educational points and increase the presentation conciseness in order to convey the most information in the least amount of time. Bedside teaching should end with a brief summary and encourage self-motivated learning by suggesting relevant publications.

Simulation-based skill acquisition

The effectiveness of simulation training to promote technical skills is well established [10]. Recently, in-situ simulation, involving the ICU team and ICU, has been found to effectively promote nontechnical skills, such as multidisciplinary team performance [69▪▪,70,71▪,72–76]. Yet, there is a surprising lack of literature on an integrated approach to promote technical and nontechnical skills. Best practice involves a three-step goal-directed approach:

(1) Simulation Bootcamp: all new residents participate in a simulation session covering four key technical skills: defibrillator/pacemaker, intraosseous catheter placement, automatic chest compression device, and basic airway skills. All trainees have to demonstrate their proficiency by correctly performing them to the instructor.
(2) Weekly in-situ critical scenario simulation sessions are performed *in* the ICU, involve the ICU team, and focus on nontechnical skills and multidisciplinary team training. The simulations cover common resuscitation scenarios and conclude with an extensive debriefing session.
(3) On-demand simulation sessions are offered to any ICU team member, if they wish to deepen their technical skills.

FEEDBACK

Feedback forms the core of any teaching program. Providing timely, detailed, specific, constructive, nonjudgmental feedback contributes to increased quality and utility of feedback. Yet, despite continued calls for feedback, it continues to be something faculty struggle with [4]. In addition to lack of training, obstacles include limited time and low institutional prioritization [77]. Nontechnical skills, such as professionalism and communication are routinely cited as the most challenging to provide feedback on and have met with the most limited success [5▪]. Approaches to providing effective feedback include faculty training, use of prompts, allocation of dedicated time, and use of multiple sources.

(1) Faculty training is critical in ensuring provision of high-quality feedback. Courses can be conducted in person or online, albeit role play and clinical examples are best managed in live workshop formats. Multiple sessions over time are often required to adequately train faculty, although some programs have been successful at improving elements of feedback with only a single session [78].

(2) Allocation of dedicated time allows the team to be prepared for feedback provision and sets a clear expectation that it should be provided. This should be set forth in prerotational expectations as outlined earlier. Priming learners to expect and solicit feedback helps overcome faculty reservations about engaging in feedback provision.
(3) Prompts can take the form of physical handouts, cards, e-mail or texts to suggest feedback provision. Physical cards can be made available to staff or placed in key locations to better equip staff to engage in providing feedback. Some mobile friendly electronic systems exist to do this, including MyTIPreport; more are under development [79].
(4) Multisource feedback can augment faculty assessments. This approach is particularly germane in the ICU, where learners work in multidisciplinary teams and their behaviors are observed by experienced nonphysician providers. Patient surveys, observational checklists, and video recording for later review have all been applied with some success, with more tools being created based on identified needs [80–83].

CONCLUSION

Conceptual frameworks provide a deeper understanding of the factors contributing to an effective and evidenced-based education in the ICU [1,3,6▪▪,7,8▪▪]. Direct teaching should be goal-oriented, sequential, adjusted to the level of the learner, and performed in a professional environment. The ICU curriculum should optimize cognitive load, reduce stress unrelated to the activity, and include training focused on helping trainees to become more 'stress-resistant [10,33,84]. In-situ simulation is a powerful tool to promote technical and nontechnical skills [70,71▪]. Feedback is both essential and challenging to accomplish; training, prompts, dedicated time allocation, and use of multisource can serve to enhance the feedback experience [5▪].

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