Chapter 2

A Conceptual Model for Nurse Anesthesia Education

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Key Points

- This chapter presents a conceptual model for nurse anesthesia education. The model explains the required declarative, procedural, and conditional knowledge components in advanced knowledge acquisition.
- The model demonstrates that acquisition and integration of these knowledge bases are best accomplished using metacognitive strategies during case-based instruction.
- Patient-centered strategic thinking evolves in learners as a result of real-world practice applying theory and principles with a large number and variety of cases.
- Learning to be cognitively flexible, to adaptively reconstruct knowledge to tasks involving new situations, also requires guidance from expert mentors. Mentors can best assist a student to achieve these goals and to progress through the stages of learning by aiming instruction within the student's zone of proximal development.
- Many teaching strategies, such as scaffolded instruction and reflection in action, can be employed in the clinical area; however, in assisting a student to become an independent problem solver, dialogue between student and teacher is essential.
- The conceptual model can be used by students and faculty as an organizing framework to facilitate the outcome of maximizing student learning during clinical experiences. It can also serve as a conceptual framework for educational research and curricula development.

Introduction

Excellence in nurse anesthesia education has been firmly established over the past century. Today's nurse anesthesia educational programs are often viewed by nursing educators as premier graduate-level nursing programs. With the multitude of operating rooms and clinical sites used by nurse anesthesia educational programs in the United States today, practicing nurse anesthetists find they are often involved in clinical teaching at some point in their careers. This chapter presents an educational conceptual framework to provide a vocabulary and principles of clinical instruction to assist nursing educators to do what they do even more effectively.

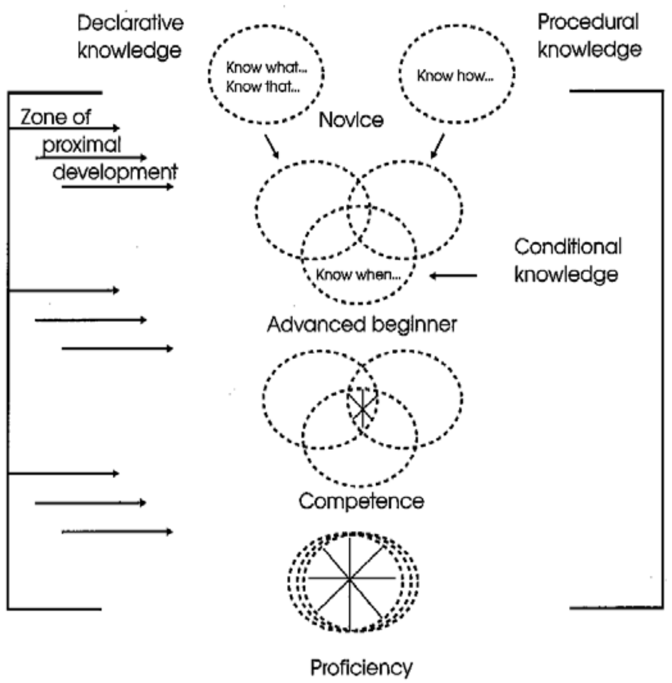
It is often said that theory guides practice and that practice informs theory. In this chapter, theoretical principles to guide case-based nurse anesthesia education are presented within the framework of a conceptual model. The model demonstrates how student nurse anesthetists, with the aid of expert mentors and using metacognitive strategies, gradually integrate the 3 essential knowledge bases (declarative, procedural, and conditional knowledge) as they become competent and proficient nurse anesthetists. Full integration requires case-based instruction in the clinical area through which learners are aided to view the conceptual terrain from multiple perspectives as they learn to think strategically in providing the best solutions to patient anesthetic challenges. The model can be used by learners, but as importantly, the model demonstrates how faculty can assist learners as they gradually progress through the stages of learning. The model may also serve as a diagnostic tool for identifying problems when student progress is not as anticipated. The model has been tested and used as a conceptual framework in research and curricula development.[1]

Background

The conceptual model of nurse anesthesia education (Figure 2.1) is guided by a constructivist ideology. Constructivism is a collection of theories and ideas about different issues in pedagogy informed by a range of philosophical and epistemological outlooks, each adding a different dimension, but all complementing each other. Learning theories within the constructivist paradigm view all learning as inherently situated, that is, embedded in social and physical environments that reflect real-world complexity. Learning is also viewed as being based on a learner's prior knowledge, which means learners must integrate all newly acquired knowledge into their existing knowledge and skills. Teachers are not viewed as transmitters of knowledge but as guides who facilitate learning. Constructivist philosophy is often seen within teaching modalities employed by the professions.

Although variations in educational curricula exist among and within professions, professional education usually includes 3 types of educational experiences: (1) courses in the basic arts or the basic sciences, (2) courses addressing the profession's typical problems and activities taught in a classroom setting, and (3) the professional initiation—apprenticeship or internship experience. Instruction in each area is essential if students are to learn to think as professionals.[2]

Figure 2.1. The Conceptual Model of Nurse Anesthesia Education



Kuhn[3] described a change in thinking that occurs when a student of physics (novice) learns to think as a physicist (professional). "Looking at a bubble-chamber photograph, the student sees confused and broken lines, the physicist, a record of familiar subnuclear events. Only after a number of transformations of vision does the student become an inhabitant of the scientist's world, seeing what the scientist sees and responding as the scientist does."[3] This transformation of vision that Kuhn refers to results from theory-based instruction coupled with real-life experience. Unfortunately, in many professions, little attention has been given to systematic inquiry of adult educational means and ends.[2] One reason for the lack of empirical studies is that professional education suffers from 2 types of insufficient theory. First, there is no theory of action for the profession to guide educational research.[4] Second, there is little general educational theory of action for instruction. The conceptual model for nurse anesthesia education (Figure 2.1) described in this chapter can serve as an organizing framework for development, refinement, and research in nurse anesthesia educational programs. The 6 stages in the model, which will be discussed later in the chapter, are based on the original framework for skill acquisition developed by Dreyfus and Dreyfus.[5]

Skill Acquisition and Piloting an Aircraft

In the 1970s, when the US Air Force required a theoretical framework to provide an educational structure for training pilots, they turned to Dreyfus and Dreyfus,[5] who developed the theory for skill acquisition. The skill acquisition that occurs in learning to fly aircraft is particularly relevant to nurse anesthesia because they (piloting an aircraft and administering an anesthetic) are often seen as analogous. The takeoff of the aircraft is similar to the induction of anesthesia, the landing to the emergence from anesthesia, and the time during anesthetic maintenance to cruising.

Piloting an aircraft and administering an anesthetic demand continuous processing of information. The pilot's monitoring and scanning of gauges and dials is analogous to the anesthetist's vigilant monitoring of patients while scanning dials and gauges on the anesthesia equipment.[6] The Dreyfus model for skill acquisition developed to assist in pilot training is used to inform the conceptual model of nurse anesthesia education (see Figure 2.1).

Dreyfus and Dreyfus were pioneers in advocating the use of computer-assisted instruction in teaching advanced skill acquisition. This model of instruction had its beginnings in interactive desktop personal computer programs. In the aviation industry, it evolved into the development and use of flight simulators in training pilots. Today, both desktop computer programs and high-fidelity anesthesia simulators are used in many training programs, and simulated instruction in anesthesia and anesthesia crisis management have become widespread.[6,7] Simulated training can provide interactive learning environments where students can apply theoretical principles, coupled with practical skills and critical thinking, in risk-free environments.

The Dreyfus model of skill acquisition has 6 stages: novice, advanced beginner, competent, proficient, expert, and master (Table 2.1). The Dreyfus model illustrates that skill acquisition occurs systematically as students progress through each stage of learning.[8] The *novice* follows rules and is unable to appreciate the unique situational aspects of an experience. The *advanced beginner* has gained some experience, and based on this, begins to recognize situational elements. The *competent* performer uses plans and begins to incorporate his or her point of view into the plans. The *proficient* performer has gained more experience and has a deeper, more involved understanding. The *expert* performer has mastered analytical decision making and has developed intuitive knowledge. In each stage, the learners' sophistication in thinking and monitoring of his or her thinking increases.

Metacognition

An essential element in skill acquisition is the concept of monitoring one's thinking. This concept was further developed by other learning theorists. Flavel[9] coined the term "metacognition" to define the concept in 1977. Metacognition, or monitoring our own thinking, is essential to learning in all education. It enables learners to draw on various thinking strategies and then to accurately assess their current understanding of a situation in light of those strategies. Using metacognitive strategies, learners become aware that they are developing new thinking skills

Table 2.1. Components of Skill Acquisition

Skill level	Components	Perspective	Decision	Commitment
Novice	Context-free	None	Analytical	Detached
Advanced beginner	Context-free and situational	None	Analytical	Detached
Competent	Context-free and situational	Chosen	Analytical	Detached understanding and deciding involved in outcome
Proficient	Context-free and situational	Experienced	Analytical	Involved understanding, detached deciding
Expert	Context-free and situational	Experienced	Intuitive	Involved

(Adapted from Dreyfus and Dreyfus[8] with permission from the Air Force Office of Scientific Research, Arlington, Virginia.)

as problem solvers. The development of these new thinking skills requires real-world and/or realistic-world (simulated) experiences.

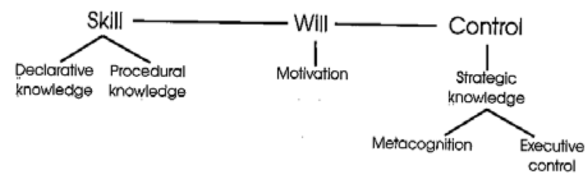
The conceptual model of nurse anesthesia education was first grounded in the work of Dreyfus and Dreyfus, then informed by the work of other constructivists and learning theorists whose contributions are described. Effective learning requires the cognitive and control strategies of skill, will, and control (Figure 2.2). Skill subsumes declarative knowledge (knowing what to do) and procedural knowledge (knowing how to do it). Although both knowledge bases are important, they are not sufficient for effective learning. Even knowing when to do it (conditional or strategic knowledge) is not sufficient. Learners must also have the will to learn, that is, they must possess the desire and motivation to learn.[10]

The components of skill, will, and control are interdependent variables, and the extent to which each contributes to successful learning may vary from student to student. Prior success with effective learning strategies assists learners with subsequent learning; however, student motivation is also essential, and students who possess less sophisticated learning strategies can overcome this obstacle and become successful learners. Conversely, highly skilled learners who lack the motivation to learn may be unsuccessful despite that advantage.

Declarative, Procedural, and Conditional Knowledge

In the conceptual model for nurse anesthesia education (see Figure 2.1), the overlapping circles represent the interdependence of declarative, procedural,

Figure 2.2. Components for Successful Learning



and conditional knowledge that is essential to learning.[11] Declarative knowledge (domain knowledge) is also referred to as systems knowledge.[12] It includes information about task structure and goals, as well as beliefs about our own-ability in relation to those goals.[11] In nurse anesthesia, declarative knowledge includes knowledge of basic sciences such as pharmacology and physiology and knowledge of applied sciences such as principles of nurse anesthesia practice. Much, but not all, of declarative knowledge is taught in the classroom and termed *didactic education*.

Procedural knowledge includes information about the execution of various actions. It is a repertoire of behaviors available to learners who select specific behaviors to attain specific goals. It includes knowledge of how to perform a procedure; for example, intubating the trachea or administering a spinal anesthetic, as well as algorithmic-type knowledge such as knowledge of the American Society of Anesthesiologists' difficult airway algorithm. Procedural knowledge is acquired from direct instruction in conjunction with repeated experience.[11]

Declarative knowledge and procedural knowledge differ from conditional knowledge, in which one must select or execute an action. Conditional knowledge describes circumstances of application of procedures. It refers to knowing when and why to take various actions. Conditional knowledge is required to adjust behavior to changing task demands.[11] Conditional knowledge provides rationale for taking various actions and is required for choosing, planning, and evaluating a selected course of action. Conditional knowledge (also referred to as strategic knowledge) includes metacognitive knowledge.[12]

Metacognitive Aspects of Learning

Being aware of being conscious is the defining feature of metacognitive knowledge. Its name means a "cognition about cognition." Monitoring our own thinking is essential for successful learning—especially in areas that require complex problem solving.[9] "One is apt to engage in a lot of cognition when there is an explicit demand for it, for example, a vocation that requires one think up and evaluate alternative courses of action, and solve complex problems. More generally there is apt to be more ideation, and more monitoring of that ideation (metacognition), when one is faced with risky decisions, especially if one believes that risk might be reduced by engaging in careful and sustained thought."[9]

Metacognitive knowledge evolves in learners as a result of planned, real-world practice with strategic thinking and technical skills. By enhancing both the frequency and quality of experiences, student insights about learning (metacognitive experiences) evolve.

Complex forms of metacognition place heavy demands on attention and occupy considerable space in working memory.[13] Consequently, student nurse anesthetists are more likely to have these types of experiences when their attention and memory permit; that is, when they have sufficient time to think about their thinking and when they are not in a highly emotional state. A student who is involved in a complex case that involves a critically ill patient may be in a highly emotional state. It is common in this type of situation for the student to be unable to answer simple questions posed by the instructor or to remember the instructor's explanations for decision making. In these instances, the instructor might best assist the student by asking a specific question after the situation has ended. Moreover, postcase conferences can provide opportunities to improve learning, especially when instructors assist students as they reflect on the prior learning situation.

Many learning theorists assert that learners have a central processor, or executive controller, that allows them to perform intelligent evaluations of their own thinking.[14] Student nurse anesthetists should not only be instructed in the use of cognitive strategies but also be instructed in how to use executive control, for example, how to employ, monitor, check, and evaluate their thinking strategies.[15] A common example of instructors teaching a cognitive strategy is teaching students in the use of differential diagnosis. Students are typically taught, for example, how to think about and respond to intraoperative hypotension by using differential diagnoses for hypotension (the etiology may be hypovolemia) as well as use of executive control (provide the patient with a fluid bolus and then reevaluate the situation). Over time, the eventual inculcation of these thinking processes will improve students' abilities to marshal the required knowledge and then construct solutions tailored to the needs of problem-solving situations in the future.

How can anesthesia instructors best assist students to develop and use self-regulatory executive control in their thinking? It has been demonstrated in many real-life situations that interactive learning experiences result in the passing of executive control from teacher to student or master craftsman to apprentice.[16] In this process, teachers are initially viewed as the supportive other, acting first as models and then interrogators. This leads students toward strategic thinking. Eventually, during these interactive processes, the self-regulatory control becomes internalized by the student and the teacher relinquishes control.

Ill-Structured Domains and Learning

Anesthesia knowledge is considered an ill-structured domain. Domains of knowledge are considered to be ill structured when required thinking and problem solving do not have predetermined algorithms. In ill-structured domains, expert mentorship and experience with a wide variety of cases are required for students to develop cognitively flexible processing skills. Also required is a learning environment that will permit knowledge to be learned in various ways and for various purposes.[17-22]

Although students progress incrementally through the 6 stages of learning in the conceptual model for nurse anesthesia education, the teaching and learning that occurs within each stage is not always linear and orderly. This is true of learning that occurs in all ill-structured domains. In ill-structured domains, practitioners must construct actions that are most appropriate and efficient for the task at hand.[17-22] Learning in these disciplines is best accomplished through case-based instruction with the goal of fostering cognitive flexibility.

Cognitive Flexibility

Cognitive flexibility is required for successful performance in ill-structured domains such as anesthesia. This is because the goals of learning must shift from the attainment of superficial understanding of facts to mastery of important aspects of conceptual complexity, and from knowledge reproduction to knowledge use, which is the ability to apply what was taught in new and varying contexts.[17-22]

In introductory learning (most undergraduate learning), the goal is often exposure to subject content or general orientation to a field of study, and learning assessment usually involves simple recognition or recall. In advanced knowledge acquisition, students must attain a deeper understanding of content material, reason with it, and apply it flexibly in diverse situations.[17-22]

The best ways to learn and instruct others to achieve cognitive flexibility for future application are nonlinear and through case-based instruction.[17-22] Although student nurse anesthetists can initially learn the basic concepts in a linear context, eventually emphasis must be shifted from retrieval of intact knowledge structures (eg, recitation of a mnemonic) to construction of new understandings. The goal is case-specific knowledge assembly drawn from multiple sources to address the problem-solving needs of the current situation. To adapt knowledge to tasks involving new situations requires metacognitive executive control strategies (predicting, planning, checking, evaluating, and revising) and flexible knowledge structures.[17-22] A main goal of instruction in nurse anesthesia is to assist the student in developing cognitive flexibility.

To foster development of cognitive flexibility in students, cases must be studied as they occur in their natural, complex situations. By focusing a student's learning at the level of individual cases and then providing experiences with a large number of cases, successful student performance will be enhanced.[17-22]

Seven themes comprise the different facets of cognitive flexibility. In the conceptual model of nurse anesthesia education (see Figure 2.1), these themes are represented by the crisscrossed lines in the middle of the overlapping circles (knowledge domains).

Theme 1: Avoidance of Oversimplification and Overregularization

In advanced knowledge acquisition, educators must emphasize ways that knowledge is not as simple and orderly as it might first seem.[22] In other words, instruction must include measures to demonstrate complexities and to show how the superficially similar can be dissimilar. The problem is that oversimplification can lead to reductive bias. For example, when conceptual elements that are highly interrelated are treated in isolation, learners may miss important parts of their interaction.[17-22]

Teachers are often inclined to oversimplify in an attempt to increase the novice's initial understanding of a concept. The problem with this is that it can instill "habits of the mind" that are later hard to break. It is actually better to introduce complexity early, but in a manageable manner. For example, in teaching students the lower acceptable limits of mean arterial blood pressure for deliberate hypotension, one instructor may simply teach that the safe lower limit is 50 to 55 mm Hg (the lower limit of cerebral autoregulation). Another instructor might initiate a discussion with the student about variables that influence decision making, such as patient positioning, blood pressure measurement relative to the brain, and the patient's underlying diseases (such as sickle cell anemia). Avoiding initial oversimplifications allows students to gain appreciation of complexities in cases and increases the likelihood that learners will take into account more factors when confronted with similar situations in the future.

Another example of the principle of avoiding oversimplification is found in the clinical assignment of anesthesia cases. It is common to see beginning students assigned to the "bread and butter" cases; however, by occasionally assigning them more complicated cases, the instructor will expose them to complexity early, and they will understand that cases may not be as simple as they initially appear. This will not be a wasted experience for students. Although students may not understand all the components, the learning that occurs will be within the context of the complexity of the case. In these instances, instructors are responsible for case management while keeping students engaged by giving them tasks they are able to accomplish.

Theme 2: Multiple Representations

In ill-structured domains such as nurse anesthesia, if cases are treated narrowly in the educational process, the ability to process future cases will be limited. There will be an assumption by students that cases are simpler than they are, and subsequent analysis of new cases will conclude prematurely.[17-22] Also, the learner's reasoning based on precedent cases will result in truncated decision making after only partial analysis of the problem. For example, the etiology of tachycardia can be an inadequate level of anesthesia, and beginning students often observe this during the induction of anesthesia. A student who does not have experience with many cases might reflexively (truncated decision making) increase the concentration of the volatile agent when a patient's heart rate suddenly increases. In this case, the student is not considering the many other things that could be the cause of the tachycardia.

Theme 3: Centrality of Cases

The more ill structured the domain, the poorer the guidance for knowledge application from top-down structures will be. Application of knowledge in ill-structured domains cannot be prescribed in advance by general principles because cases vary greatly with respect to which conceptual elements will be relevant and in what combinations. Overreliance on precompiled knowledge structures such as fixed protocols is a teaching and learning error.[17-22] Certain combinations of drugs work well for typical cases, and beginning students feel more comfortable when given "recipes" for case management; however, experienced nurse anesthetists know that they must always make adjustments to their anesthetic plan and titrate to effect. Students' future decision making and practice skills benefit more when instructors teach them to titrate drugs and tailor anesthetics based on patients' needs instead of giving them prescribed recipes for anesthetic management.

Theme 4: Conceptual Knowledge Is Knowledge in Use

In ill-structured domains, the meanings of concepts are connected to their patterns of use. When use of a concept has a complex and irregular distribution, prepackaged prescriptions for proper activation of the concept cannot be provided.[17-22] A concept has many different uses in cases, and each concept must be tailored to the context of its application. A student may know a fact but may not be able to apply it to a particular case. For example, a student may understand the concept of the carbon dioxide response curve and accurately draw the curve indicating the effect volatile agents and opioids have on it; however, at the end of a case when the student gives a patient a small amount of opioid for postoperative pain control and the patient's respiratory rate declines, the student may not be able to understand the activation of that concept without assistance.

Theme 5: Schema Assembly (From Rigidity to Flexibility)

In ill-structured domains, the goal is to teach students to assemble knowledge from different theoretical and precedent case sources to adaptively fit the situation at hand. Knowledge in nurse anesthesia is used in far too many ways for them all to be anticipated in advance. There must be a shift in learning from retrieval of intact knowledge structures to situation-specific problem solving.[17-22] We sometimes hear students say "We weren't taught that," meaning "We weren't taught exactly that." One learning goal is to foster students' ability to think for themselves and use their knowledge in new ways. It is important for them, as well as for their instructors, to understand and work toward this goal.

Theme 6: Noncompartmentalization of Concepts (Multiple Interconnectedness)

Because of the irregular way various features weave through cases in ill-structured domains, knowledge cannot be neatly compartmentalized. A student strategy frequently encountered in didactic education is relegation of knowledge into separate compartments. For example, students learn anatomy in 1 course and pharmacology in another, often making lists or using mnemonics as study aids to pass examinations. The problem is that students often miss the interconnectedness of concepts and their applications along multiple conceptual and clinical dimensions.[17-23] An example of clinical instructors assisting students with interconnectedness is a case-based discussion about principles of basic science that informed a particular practice decision.

Case-based instruction can highlight important, instructional relationships between aspects of 1 case and aspects of another. Understanding what to do in a given case usually requires reference to more than 1 prototype—the case will be "kind of like this earlier one, kind of like that one." Postcase conferences are a way instructors can assist students in understanding relational aspects of cases. Identifying common denominators among a series of cases is a common teaching strategy. It is also important to highlight aspects of the cases that are different; for example, the patients' differing underlying disease processes, pain tolerance, or body habitus, and how these differing aspects may have influenced case management.

Theme 7: Active Participation

Knowledge cannot be simply handed to student nurse anesthetists. There must be active learner involvement in knowledge acquisition, accompanied by guidance and commentary from expert mentors to help them derive maximum benefit from their experiences. When instructors aim toward the goal of cognitive flexibility, they can build integrated knowledge structures that permit greater flexibility in the ways knowledge can potentially be assembled and used or transferred to different situations. On the other hand, overreliance on automation processes can lead to performance errors. One such error is the continuation of a course of action or strategy when it would be rational to change to an alternative course because conditions have changed (cognitive blockade). Another error might be seen in a person who, lacking cognitive flexibility, adheres to a decision when it has been demonstrated to be a mistake or who persists in a false diagnosis when new information suggests otherwise. A lack of cognitive flexibility can lead a student to consider only part of a problem because he or she is putting information into precompiled knowledge structures that do not fit the situation at hand. To help avoid these types of errors, it is important to teach students to be cognitively flexible so they can adapt their behaviors appropriately to changing situations.

Thinking Out Loud and Gradually Ceding Control

In teaching student nurse anesthetists, it is important to provide opportunities to develop flexible, declarative, procedural, and conditional knowledge structures with cases containing complexity. Clinical instruction must be provided in ways that allow students to gain the most from their experiences.

It takes time to learn to think strategically as a professional because the learner's process of internalization occurs gradually. Initially, teachers control and guide students' activities. Later, they share control over problem-solving functions; the students take initiatives and teachers correct and guide when students make mistakes. Finally, teachers cede control to students and function primarily as a supportive and sympathetic audience. This type of instruction is not unique to nurse anesthesia. Teachers, tutors, and master craftspersons in traditional apprenticeship situations all function as promoters of self-regulation (executive control) by nurturing the emergence of self-control while gradually ceding external control. For example, an instructor confronted with a problem during an anesthetic could model the thought processes used in decision making by thinking out loud. After allowing the student to observe several examples of this strategic thinking, the instructor could then allow the student an opportunity to demonstrate problem-solving strategies. Gradually, after many successful demonstrations, the instructor could cede control of the problem solving to the student. For example, an instructor could think out loud while managing the patient undergoing an abdominal aortic aneurysm resection, during which fluid management can be extremely difficult. The decisions about fluid management, blood volume, and vasodilator therapy are complex and there are no formulas to guide therapy. The aorta is typically cross-clamped to facilitate surgical repair. To prevent hypotension during aortic cross-clamp removal, the vascular space is typically dilated and filled with intravenous fluid so that maximum cardiac output can be achieved. The vasodilator is stopped before declamping and while rapid volume administration is often initiated. By first modeling the decision-making strategies by thinking out loud for the student's first 2 abdominal aortic aneurysm resection cases and allowing the student to be the decision maker in the third case, the instructor gradually cedes external control over problem solving to the student, while correcting and guiding when mistakes are made.

Scaffolded Instruction

Scaffolded instruction is a concept developed to describe the assistance a teacher can offer a learner. The instructor provides initial support, or scaffolding, until the student is ready to be more independent, and then the instructor removes the scaffold when the student is ready. In successful scaffolding, the instructor initially ascertains the students' prior knowledge so that it can be connected to the new knowledge and made relevant to the learner. There are many ways that an instructor can use scaffolding in student learning. Instructors using scaffolding can break the tasks into smaller, more manageable parts; think out loud to verbalize their thinking process when completing tasks; and use questioning, coaching, and modeling to reinforce the learning of concepts. Other methods include the activation of background knowledge by providing tips, strategies, and cues.

Nurse anesthesia instructors frequently use the think-out-loud strategy, which models forms of executive control over thinking and problem-solving activities. The goal is to assist students in becoming successful independent thinkers and problem solvers. Another common strategy is for an instructor to initially use an explicit directive and then be less directive the next time the student needs assistance. Regardless of the specific technique used, scaffolding should be removed, fading gradually, and then completely when the student demonstrates mastery of the task.[23,24] The teacher must keep the learner in pursuit of the task while minimizing the learner's stress. Skills or tasks too far out of reach or tasks that are too simple can lead to student frustration.[24,25]

The Zone of Proximal Development

Central to using scaffolded instruction to assist students to become independent problem solvers is the role of dialogue between teachers and students. The purpose of dialogue is to provide students with just enough support and guidance to achieve goals that are beyond their unassisted efforts. In accomplishing this, teachers must understand the zone of proximal development. This zone is depicted by the arrows to the side in the conceptual model for nurse anesthesia education (see Figure 2.1). Vygotsky, who developed the concept, defines this as the distance between the learners' actual developmental level (determined by independent problem solving) and the level of potential development (as determined through problem solving with the guidance of mentors).[26-28] Once the student has increased knowledge, the level of development expands and the zone of proximal development shifts. Thus, the zone is always changing as the student gains knowledge, and instructors using scaffolded instruction must constantly individualize their interactions with each student in response to the changing zone of proximal development.

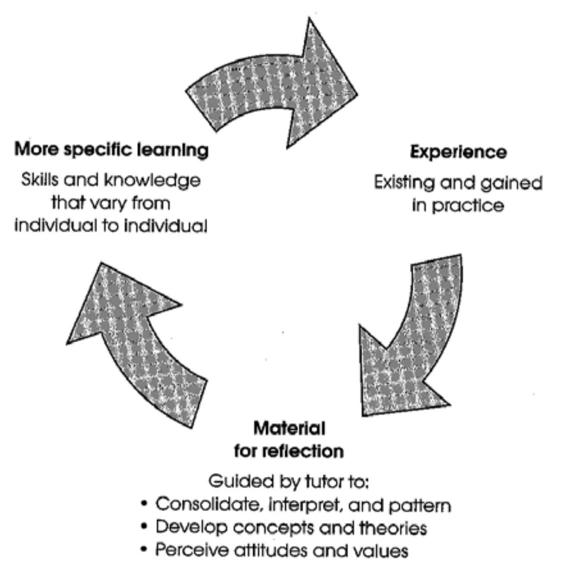
It is important that the instructor appropriately assesses the zone of proximal development. Misjudging the zone could lead to underinstruction and boredom or frustration because of instruction beyond the student's abilities. Scaffolded instruction includes the following components[29]:

- Recruitment: The instructor must recruit the student's interest.
- Reduction in degrees of freedom: The instructor must reduce the size of the task to the level that the student can fit with task requirements.
- Direction maintenance: The instructor must keep the student in pursuit of the task.
- Marking critical features: The instructor must accentuate features of the task.
- Frustration control: The instructor must help reduce stress to make the situation less stressful than if the tutor had not been present.
- Demonstration: The instructor must demonstrate an idealization of the task by completing the task or explicating a solution that is beyond the learner's current ability.

Planning and use of instructional strategies such as scaffolded instruction when engaging in clinical teaching will result in a more productive student learning experience and a smoother progression through the stages of learning.

Because all learning begins with the experience of the learner (what the student already knows), it is important to ascertain the student's current knowledge level.

Figure 2.3. Experience as the Driving Force for Reflection and Learning



(Adapted with permission from the British Further Education Unit, London, England.[30])

In anesthesia, students are experienced critical care nurses who have a wealth of knowledge and experience; however, the first step may be the need to clarify learned misconceptions.

In all cases, students will gain maximally from scaffolded instruction when they have experiences that are then accompanied by reflective activities guided by instructors (Figure 2.3).[30] Nurse anesthesia instructors can best assist students' learning by providing them with experiences (real-world and simulated cases) that require deliberation and action. A method to assist them in analyzing situations is the use of reflection.[31] Schön describes this process as reflection in action.[32,33]

Reflection in Action

Practitioners first make sense of new situations by imposing a structure that often comes through analogy to other previously encountered situations. They then build, through these experiences, a repertoire of examples, images, understandings, and actions. When they encounter a new situation similar to something already present in their repertoire, they bring past experience to bear on the case, which enables them to see an unfamiliar situation as a familiar one. Schön also describes a scaffolding method of assisting students by reflecting their thinking back to them so they better understand their own deliberations.[31,32] The notion of zones of development are recast by Schön as zones of mastery.[32,33] By having the learners engage in reflection, instructors teach them how to be metacognitively aware of their own thinking processes. This has been termed *cognitive apprenticeship* or *collaborative learning* and can lead to important insights for instructors as well as students. Master teachers value learners' expertise and encourage them to take responsibility for their own educational needs. This eventually leads to a sense of empowerment that is important for lifelong learning.[33] Finally, both learners and instructors must be aware that instructors also advance through the stages of a parallel educational model as they progress from novice to master teacher.

The instructor must have a reflective and flexible educational style that is tailored to the individual learner. Learners can enrich an educator's experience in ways that may inform the instructor's own practice. Those who reflect on their teaching styles can become more capable of adjusting their approaches to allow for students' needs and learning styles.[34]

Summary

Nurse anesthesia is a complex domain that requires mastery of a broad range of components that, when combined, reflect the real-world complexity of the field. Prepackaged prescriptions for action do not exist in nurse anesthesia because the diversity of all possible scenarios is impossible to anticipate. The goal of education is for students to acquire a mastery of experiences with a broad range of cases that reflect the complexity of anesthesia practice. To accomplish this, learners must assimilate knowledge from a variety of sources to construct solutions that suit the problem-solving needs of the situation at hand. To achieve a level of successful performance as entry-level providers, student nurse anesthetists need experience applying theory and principles to a large number and variety of cases.

Understanding the stages through which skillful performance develops is important in designing educational programs and materials. This information will facilitate the acquisition of advanced knowledge and cognitive flexibility. To assist learners as they progress through the stages of learning in case-based instruction, it is essential to identify at each stage which capacities the learners have acquired and which ones they may be in a position to attain. The role of the teacher is that of an expert mentor who guides students' learning through reflective deliberations and facilitates their acquisition of higher-order skills. Through this process, expert mentors using appropriate applications of anesthesia and educational theory can assist learners in developing the sophisticated, integrated knowledge structures that are required for adaptation of behavior to rapidly changing situations.

On completion of an educational program, graduate nurse anesthetists will have successfully progressed through the first 4 stages of the model. On completion of the proficiency stage, graduates can safely and independently administer anesthesia as entry-level nurse anesthetists after passing the national certification examination. Some graduates will be content to practice proficiently and will not attempt to progress further. A few will even regress to the stage of competence, still able to safely administer an anesthetic but requiring much direction. Those content to practice at the competent stage will not keep themselves informed of advances in the field. Those graduates who wish to continue to learn about the art and science of nurse anesthesia can develop into expert nurse anesthetists. Expert nurse anesthetists are confident and secure in their practice because they have excellent clinical and critical-thinking skills. Through continued study, expert nurse anesthetists maintain up-to-date declarative, procedural, and conditional knowledge bases.

Some nurse anesthetists will continue their professional growth and achieve the sixth stage, *master*. Those functioning at this level will formally or informally deepen their understanding of nurse anesthesia, usually through intensive study in a specific area. These anesthetists are often the ones who advance the science of the profession through teaching, writing, managing, or conducting research.

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