Educational Strategies Associated with Development of Problem-Solving, Critical Thinking, and Self-Directed Learning

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Abstract: This article was developed for the Commission on Change and Innovation in Dental Education (CCI), established by the American Dental Education Association. CCI was created because numerous organizations within organized dentistry and the educational community have initiated studies or proposed modifications to the process of dental education, often working to achieve positive and desirable goals but without coordination or communication. The fundamental mission of CCI is to serve as a focal meeting place where dental educators and administrators, representatives from organized dentistry, the dental licensure community, the Commission on Dental Accreditation, the ADA Council on Dental Education and Licensure, and the Joint Commission on National Dental Examinations can meet and coordinate efforts to improve dental education and the nation's oral health. One of the objectives of the CCI is to provide guidance to dental schools related to curriculum design. In pursuit of that objective, this article summarizes the evidence related to this question: What are educational best practices for helping dental students acquire the capacity to function as an entry-level general dentist or to be a better candidate to begin advanced studies? Three issues are addressed, with special emphasis on the third: 1) What constitutes expertise, and when does an individual become an expert? 2) What are the differences between novice and expert thinking? and 3) What educational best practices can help our students acquire mental capacities associated with expert function, including critical thinking and self-directed learning? The purpose of this review is to provide a benchmark that faculty and academic planners can use to assess the degree to which their curricula include learning experiences associated with development of problem-solving, critical thinking, self-directed learning, and other cognitive skills necessary for dental school graduates to ultimately become expert performers as they develop professionally in the years after graduation.

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In 2004, the Board of Directors of the American Dental Education Association (ADEA) identified curriculum development to meet the changing needs of oral health care as one of the Association's strategic directions. Nearly every Council within ADEA, including Deans, Sections, Faculties, Allied Dental Program Directors, and Hospitals and Advanced Education Programs, has created an initia-

For further information on this topic, refer to Bill Hendricson's presentation "Educational Best Practices" and the companion bibliography posted in the ADEA Scholarship of Teaching and Learning Community, www.adea.org.

tive related to curricular change in recent years. In 2005, then-ADEA President Eric Hovland created the ADEA Commission on Change and Innovation in Dental Education (CCI) as the Association's primary mechanism to lead and coordinate ADEA's efforts to assist in the development of curricula for the twenty-first century. The CCI is chaired by Dr. Kenneth Kalkwarf, Dean of the Dental School at the University of Texas Health Science Center at San Antonio, and 2006-07 President of ADEA.

A number of organizations and stakeholders influence the goals, scope, structure, and directions of dental education in the United States. Most of these groups operate independently of each other in adopting policies, positions, and regulations that affect dental education. The underlying philosophy of the CCI is that effective change and innovation in dental education can take place only when each of the component organizations agrees on fundamental improvements to dental education. To provide a forum for building such consensus, CCI was created to be the focal meeting place in dental education where these constituencies—including dental educators and administrators and representatives from organized dentistry, the dental licensure community, the Commission on Dental Accreditation, the ADA Council on Dental Education and Licensure, and the Joint Commission on National Dental Examinations—can come together with the purpose of coordinating efforts to improve dental education and thereby the oral health of the public. While recognizing the diversity of dental school missions, the CCI has engaged a special ADEA Council of Sections task force to provide a benchmark for predoctoral dental education by preparing an updated set of competencies for the entry-level general dental practitioner. The CCI will pursue a variety of other initiatives, including faculty development programs focused on curricular change and innovation. During 2006-07, the CCI will publish a series of white papers to address critical considerations in curricular innovation. The preamble to this series, "The Case for Change in Dental Education," appears in this issue of the *Journal of Dental Education.* Subsequent publications and reports from the CCI will address additional factors influencing the dental landscape, including the influence of emerging science on curriculum, access to dental education and oral health care, dentistry and dental education in the context of the evolving health care system, best practices for faculty development, and strategies for assessment.

This first white paper reviews evidence related to the fundamental curricular question: What are best practices for helping dental students acquire the capacities to function as an entry-level general dentist? Three issues are addressed, with special emphasis on the third item:

1. What constitutes expertise, and when does an individual become an expert?
2. What are the differences between novice and expert thinking?
3. What educational best practices can help our students acquire the mental capacities associated with expert function, including critical thinking and self-directed learning?

1. What Constitutes Expertise, and When Does an Individual Become an Expert?

The primary mission of dental school is to produce an entry-level general practitioner who has the capacity to function independently without supervision. The cornerstone of professional practice is the application of thought processes that allow dentists to recognize pertinent information in a patient's presentation, make accurate decisions based on deliberate and open-minded review of available options, evaluate outcomes of therapeutic decisions, and assess their own performance. Before delving into the cognitive processes that allow dentists to "do what they do," a few notes about the novice to expert continuum are warranted to provide a context for the following discussion of expertise.

The process of developing the capacity for expert thought and skillful on-the-job performance typically extends well beyond the temporal confines of in-school education.[1] In the 1980s, the Dreyfus brothers popularized the five-stage development continuum that consists of novice, advanced beginner, competent, proficient, and expert.[2] An individual in training for a professional role evolves from a true neophyte (a beginner; derived from the term "novice" used in religious orders) through a series of stages where capacities are gradually and progressively enhanced by trial and error learning and successive approximation supported by timely and corrective coaching. The "safe practitioner stage," in which an individual can perform the core tasks associated with a professional role and solve commonly encountered problems without assistance, is often equated with being "competent"—the launching point for acquiring the fluid, seamless, accurate, and flexible performance that is the hallmark of true expertise.

There has been considerable debate among educational psychologists and cognition specialists, much of it semantic in nature, about whether the desired graduate of professional education should be competent, proficient, or even possessing some aspects of expertise. How long it takes to acquire true expertise also has been the source of much debate among cognitive scientists. The most frequent answer to this question by many of the investigators referenced in this article is a conditional "five to ten years depending on many factors." These factors include the inherent difficulty of the skills the individual is attempting to acquire, the frequency of practice, opportunities for progressively increasing levels of challenge and responsibility in work after completion of formal school-based training, and the availability of a mentor to serve as a coach and role model.[3-4] Thus, for purpose of clarification, this article takes the "long view" of expertise over the entire development continuum and will focus on how to best prepare students to ultimately reach a level of expertise. All experts on expertise believe that the "seeds must be sown" during the in-school phase of professional education. Graduates from dental school will rarely have the capacity to function as true experts immediately upon graduation, but hopefully are competent entry-level performers who can provide the fundamental skills associated with general dentistry and are well on their way to achieving expertise with practice and refinement over the next several years.

Based on research from aeronautics, athletics, computer science, engineering, mathematics, physics, the military, and industrial settings, cognitive psychologists have identified six components of expertise (see Figure 1). Components 1, 2, and 3 are developed by overt practice and do not simply develop spontaneously with maturation. Component 4 (rapidly accessible and problem-focused knowledge) can be developed with frequent practice in problem-solving simulations.[5-11] Components 5 and 6 are largely dependent on an individual's personality (composure and confidence) and may not be amenable to development through training although positive attributes can be reinforced and rewarded.

Figure 2 displays the characteristic behavior of novices and experts while trying to solve an ill-structured problem where the solution is not immediately obvious and the outcome is not certain. The primary goal of the dental curriculum is to facilitate students' transition from the left side of the figure, which represents classic novice approaches to problem solving, to the right side, which depicts the mental processes and behavior we hope will be ultimately instilled in our graduates.[12,13]

2. What Are the Differences Between Novice and Expert Thinking?

Advances in brain imaging technology such as positron emission tomography and functional magnetic resonance imaging have allowed neurophysiologists to investigate brain functions during cognitive, perceptual, and psychomotor tasks.[14-15] Based on these technological breakthroughs, obser-

1. Pattern recognition: ability to discern pertinent information (i.e., "connect the dots")
2. Anticipatory guidance: ability to think ahead and anticipate outcomes and problems
3. Ability to accurately reflect on performance and modify behavior to improve outcomes
4. Knowledge that is quickly retrievable, useful, and situation-specific
5. Ability to maintain personal composure so that emotions do not hinder decision making
6. Confidence to make decisions even when conditions are ambiguous and outcomes uncertain

Figure 1. Six components of expertise

Novice Behavior	Expert Behavior
Rule bound; tries to implement textbook approaches	Adapts to circumstances; not locked into one particular strategy
Slow and hesitant; lacks confidence in decisions	Fast and fluid; confident about decisions; optimistic
Looks for help or even "bails out"; overwhelmed by uncertainty and ambiguity of the situation	Takes charge and provides leadership even when situation is ambiguous and outcome uncertain
Cannot access pertinent knowledge quickly	Quickly retrieves needed knowledge by largely subconscious recall of pertinent information
Slow "trial and error" efforts to solve the problem using one approach at a time; slow to recognize when strategies are not working	Settles on "best course of action" after quick review of options but willing to change course quickly if results are not satisfactory
Singular: concentrates on own needs and own discomfort in ambiguous situation; inefficient; does not manage time or resources well	Multi-task: can simultaneously study the problem and also coordinate work of others
Focus: surface features of the problem	Focus: underlying problem source
Flawed thinking:	Accurate: makes correct decisions
• Premature closure—makes decisions too fast	Avoids flawed thinking
• Anchoring—stubbornly supports poor decisions	
• Faulty synthesis—2 + 2 = 6	
• Ignores or doesn't recognize important data	

Figure 2. Characteristic behaviors of novices and experts during problem solving

vational studies that document the overt behaviors of neophytes and experienced practitioners during situations that require problem solving, and content analysis of the information-seeking steps and decision-making processes employed by trainees and practitioners, cognitive psychologists and educators have converged on a model of the way individuals structure and use information at different stages along the novice to expert continuum. Expert practitioners, represented by the right side of Figure 3, have integrated neural networks that facilitate instantaneous retrieval of chains of information relevant to task performance or problem assessment.[16-25] In contrast, novice learners, represented by the left side of Figure 3, struggle to assemble isolated bits of information, depicted by the symbols within the columns. Novices employ an inefficient trial and error approach because they lack pre-existing networks that allow fast retrieval of pertinent information. The student may have encyclopedic information (i.e., "book smarts"), but this information is compartmentalized and largely unlinked to other topics. To develop problem-solving ability, students must convert the unorganized static information (i.e., bits of data) they have "sponged" from textbooks and lectures into the interlinked chains of networked knowledge, defined as information that has meaning, value, and recognized utility and which an individual can explain in his or her own words.[21,26-28]

3. What Educational Best Practices Can Help Our Students Acquire Mental Capacities Associated with Expert Function?

Cognitive psychologists categorize "knowledge" into three areas: 1) declarative knowledge, 2) procedural knowledge, and 3) an ill-defined gray zone between declarative and procedural knowledge that includes the reasoning skills often described as critical thinking and problem solving. In the health professions, critical thinking and problem solving are often loosely defined as clinical reasoning, diagnostic thinking, or clinical judgment.

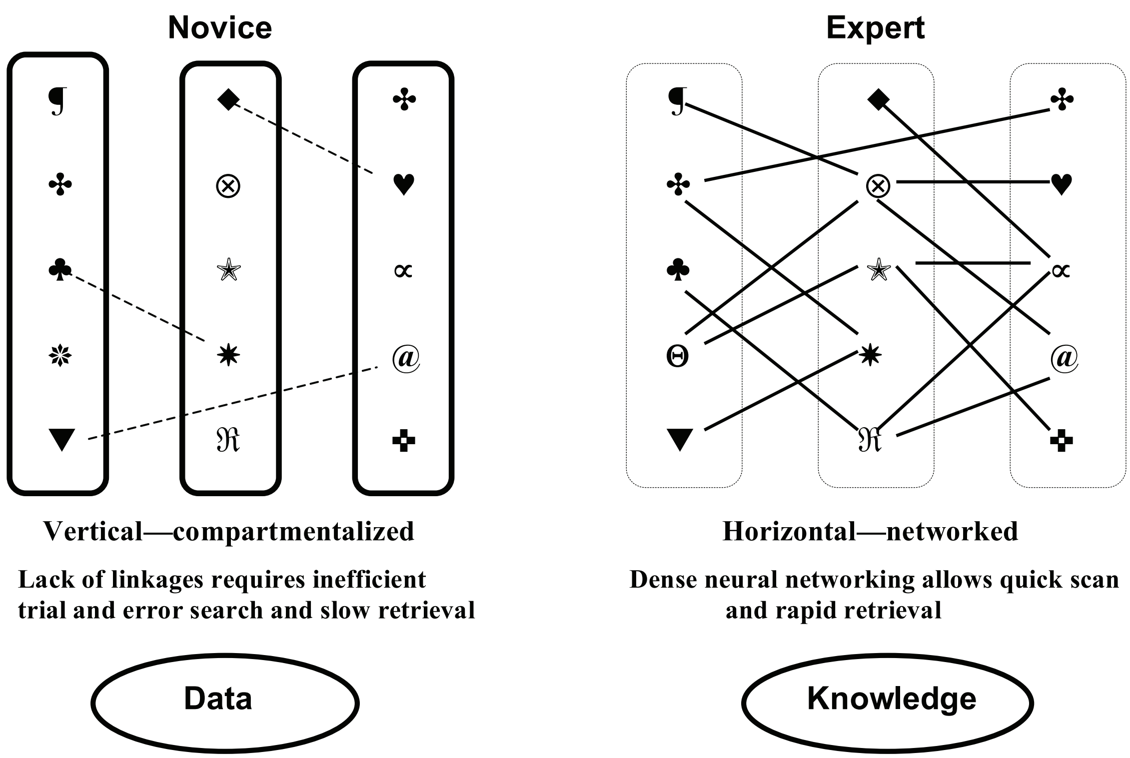
Types of Knowledge

Declarative knowledge consists of two memory components. The first is explicit memory that individuals overtly retrieve by sending a message to the brain; this is thus called "dial-up" knowledge as in dialing a phone to send a message. Explicit memory includes memories that contain factual information such as names, places, dates, terminology, and past events an individual has personally experienced that may have emotional components.

For explicit (dial-up) knowledge, seven elements are associated with effective learning:[25,29-33]

1. Communication of learning objectives for each class session;
2. Organization of the subject matter in a manner that makes sense to the learner;
3. Frequent in-class activity such as writing notes, analyzing problems, or answering questions;
4. Use of mnemonics to aid memorization of factual information;
5. Frequent in-class quizzing with immediate feedback on response correctness;
6. Total amount of "time on task" including in-class activities and personal study time; and
7. Summary of key points to remember ("take-home messages") at the end of each lesson.

The second component of declarative knowledge is generalizable rules that guide an individual's behaviors. These rules are embedded in subconsciously retrieved memory, known as implicit memory, so that the guiding action happens automatically without overt thought, as implied by the phrase "functioning on automatic pilot."[11,17,25] Implicit memory is called pop-up memory because these guiding rules



Source: Hendricson WD, Kleffner JH. Assessing and helping challenging students: why do some students have difficulty learning? J Dent Educ 2002;66(1):43-61.

Figure 3. Information storage in novices' and experts' memory

literally "pop" into consciousness without active retrieval when cueing stimuli are detected. Implicit memory consists of past experiences that influence our current behavior—for example, memory of how a particularly tricky restoration was successfully handled on a previous patient. Implicit memories are subconsciously blended into our thought formation and are usually instantly available. Implicit memory includes most of the unique mental skills that are the hallmarks of expertise: subconscious pattern recognition based on an accumulation of prior exposures to the same stimuli, coping responses (previously successful actions that kick in when certain stimuli are encountered), alertness for signals that indicate a coming event, alertness for deviations from established patterns, and ability to anticipate future actions. The last three capacities are called anticipatory guidance.

Five strategies develop implicit (pop-up) memory:[17,32,34-37]

1. Simulations in which students apply decision making for both well-defined, frequently seen problems and ill-structured, rarely encountered problems;
2. Prospective simulations in which students practice anticipatory guidance by analyzing scenarios to predict likely problems and then develop coping strategies;
3. Retrospective critique of case scenarios in which actions are reviewed to identify errors as well as exemplary performance;
4. Self-assessment of performance in comparison to best practice benchmarks; and
5. Written or verbal reflection on the meaning of experiences, especially how to avoid errors.

Procedural knowledge is the "how to do things" component of memory and is divided into discrete (isolated action) performance and continuous action performance. A discrete procedure has definite start and stop points, predictable and easily measured outcomes, and a finite series of steps that do not tax the memory limits (i.e., three to seven steps). Continuous procedures involve an ongoing series of actions that need to be coordinated with continuous monitoring of the environment: driving a car, for example, or in dentistry, the precise placement and movement of a handpiece. Engagement of multiple senses to "read" the environment is critical in continuous procedures, and the metacognitive centers of the brain are critical to success. Metacognition is the process of internal self-review that allows an individual to assess "how things are going" and modify actions based on this personal critique.[38]

Six strategies help individuals develop procedural skills:[25,39-47]

1. Practice describing, visualizing, or drawing the desired end-product;
2. Comparing the desired outcome to examples of outcomes that are not acceptable;
3. Observing task performance by an expert who explains procedures as they are executed;
4. Frequent hands-on practice with prompting (i.e., tips) and correction by a coach;
5. Feedback that allows error correction early in the learning process; and
6. Analysis of their own work process and products to compare how their techniques and outcomes correspond to best practice standards.

Development of Problem-Solving and Critical Thinking Skills

Best practice strategies for helping students learn the reasoning skills of problem solving and critical thinking remain a source of conjecture, particularly with regard to critical thinking. Research in the health professions has been based on observations of novices and experts "in action," analysis of their respective decision-making steps and accuracy, assessment of dysfunctional behaviors during problem solving, and theoretical speculation about the cognitive mechanisms involved in clinical reasoning.[12,48-50] Most of this research has occurred in medicine and nursing where some findings suggest a linkage between critical thinking capacity and soundness of clinical judgment although the generalizability of these outcomes is limited by the nature of the assessment instruments as subsequently discussed.[51] The dental education literature is fundamentally devoid of research on the cognitive components of clinical decision making. However, research on these complex skills has been stronger in aeronautics, engineering, the mathematical sciences, and performance disciplines such as dance, music, and athletics; findings from these disciplines appear to translate to the decision making by health care providers.[52]

For clarification, critical thinking and problem solving are seen by cognitive psychologists as intertwined mental capacities, and many investigators have recently merged these two concepts into a single construct labeled by terms such as reflective judgment or deliberative assessment. Critical thinking is the reflective process in which individuals assess a situation or evaluate data by using mental capacities characterized by adjectives such as compare, analyze, distinguish, reflect, and judge. Halpern defined critical thinking as "an assessment process in which all assumptions are open to question, divergent views are sought and analyzed, and inquiry is not biased or directed by predetermined notions."[53] Kurfiss described critical thinking as "the rational response to questions that can't be answered definitively and for which all the relevant information may not be available."[54] Michael Scriven and Richard Paul of the National Council for Excellence in Critical Thinking Instruction describe a "critical thinker" as an individual who

- raises questions and problems, formulating them clearly and precisely,
- gathers and assesses relevant information,
- comes to well-reasoned conclusions and then tests them against relevant standards,
- thinks open-mindedly about alternative systems of thought or alternative perspectives, and assesses their assumptions, implications, and practical consequences, and
- communicates effectively with others in determining solutions to complex problems.[55]

Critical thinking clearly underlies the components of expertise described in Figures 1-3.

The noted educator and psychologist Benjamin Bloom said that critical thinking "is the opposite of making judgments based on unexamined assumptions or untested hypotheses."[56] Much of the research on critical thinking has focused on the willingness and disposition of individuals to engage in reflective and analytical thought. Dewey observed that "possession of knowledge is no guarantee for the ability to think well—an individual must desire to think."[57] Cultivating a disposition to think critically appears to be a key component in developing the thought processes and approach to problem solving that constitutes "expertise."[58] A panel of experts on critical thinking commissioned by the American Philosophical Association identified the following dispositions as essential for critical thinking: inquisitiveness, open-mindedness, willingness to be systematic and thorough when exploring problems, capacity and willingness to be analytical when considering evidence, desire to seek truth including asking difficult or troublesome questions that challenge assumptions or conventional wisdom, willingness to continue inquiries even if outcomes do not support one's self-interests or preconceived opinions, willingness to trust the soundness of one's reasoned judgments after review of the evidence, and maturity, which includes recognition that many problems are ill structured and difficult to assess, responses may have to be implemented without complete certainty, and there may be more than one best response.[59] Because of the strong personality component underlying these dispositions, there is debate among critical thinking experts about the degree to which these traits can be cultivated in students if they are not already present at the time of admission to the academic program. In addition, questions have been raised about the capacity of available critical thinking measurement instruments to assess the type of clinical reasoning required by health care providers. Concerns also have been raised about the psychometric properties of commonly used critical thinking inventories such as the Watson Glaser Critical Thinking Appraisal and the Cornell Critical Thinking Test, which are narrow in scope, measure thinking about well-structured problems, and do not meet the Standards for Educational and Psychological Testing set by the American Psychological Association.[60]

Problem-solving is the "action-end" or implementation component of the overall critical thinking process—in other words, "where the rubber meets the road." John Dewey originally described the components of the deliberative assessment process that encompasses the intertwining of critical thinking and problem solving in 1933, and this process, represented in Figure 4, still underlies the reflective judgment process advocated in many disciplines including the health professions.[8,49,61,62]

The capacity for self-directed learning (SDL) is required to implement the reflective judgment process and underlies many of the dispositions needed for critical thinking. SDL is the ability to direct and regulate one's own learning experience.[63,64] Essentially the same educational strategies have been proposed to develop critical thinking and self-directed learning. These best practices include providing students with frequent opportunities to use the reflective judgment process described in Figure 4 to analyze problems presented in case scenarios or during the elaborate simulations employed by the aeronautics industry and the military.[65-68] The data seeking and analysis required to accomplish the reflective judgment process are thought to help students acquire SDL skills in a "learn by doing" approach, and there is evidence that students who routinely use this process to explore problems develop more sophisticated SDL than do students in lecture-based curricula.[69] Implementation of this reflective judgment process with emphasis on student-directed exploration of the literature represents the core elements of problem-based learning, which has been employed widely as a curriculum

- Identify the issues and facts in a problem or dilemma.
- Identify and explore causal factors.
- Retrieve and assess knowledge needed to appraise response options and guide actions.
- Compare the strengths and limitations of options.
- Skillfully implement the option most likely to resolve the problem.
- Monitor implementation and outcomes and modify the strategy/action as needed.
- Candidly appraise the outcomes of actions, both positively and negatively.

Figure 4. Reflective judgment process involved in problem analysis and resolution

model in medical and nursing education with generally positive acceptance by faculty and students, but to a much lesser extent in dental education.[70,71]

In addition to simulation-driven learning experiences that require application of the reflective judgment process, four additional educational strategies have been associated with enhancement of critical thinking skills:[25,51,54,72]

1. Frequent use of questions by instructors that require students to analyze problem etiology, compare alternative approaches, provide rationales for plans of action, and predict outcomes;
2. Listening to the reasoning of expert practitioners as they "talk through" their approaches to analyzing and solving problems;
3. Comparing data searching steps, strategies implemented, decisions made, and outcomes to that of expert practitioners who work through the same case scenario; and
4. Writing assignments that request students to analyze problems by discussing theories about causal factors, compare alternative solutions, and defend decisions about proposed actions.

Research on strategies to develop health professions students' critical thinking skills has been hindered by lack of valid assessment instruments that measure the type of reasoning skills needed during provision of health care services, in which problems are often ill structured with numerous confounding factors.[73] While many health professions educators are concerned about the lack of viable critical thinking assessment instruments, there is a long-standing tradition, especially strong in medicine, that the "collective wisdom" of the faculty is an adequate data source for assessment of a trainee's clinical acumen and diagnostic reasoning.[27,28,36,49,62] This assumption is based on the existence of the following conditions: 1) faculty have opportunity to observe and interact with the trainee on multiple occasions over an extended period of time and across a variety of patient care situations and problems; 2) faculty can assess the depth of knowledge and underlying logic, typically via questioning, that guides the trainee's reasoning and decision making; 3) faculty have opportunities to compare their impressions of the trainee with other instructors to reach a comprehensive or global evaluation; and 4) several counterbalancing types of data are collected, including performance on "competency" patients, written examinations, problem-solving simulations, and assessment of the trainee's professionalism.[74-76] Health professions educators who have studied evaluation of learner performance in clinical settings have mixed opinions about the extent to which these conditions occur and the resulting accuracy of faculty evaluations.[77,78] For example, a recent study of dental students' perceptions of their clinical education experiences involving twenty-three U.S. and Canadian schools indicated that inconsistent and "unfair" evaluation was their primary criticism about dental school.[79] However, on the positive side, the Self-Directed Learning Readiness Scale (SDLRS) by Guglielmino has been used effectively in health professions education to measure students' SDL and to track longitudinal changes.[80,81]

Putting It All Together

Dr. Vimla Patel, director of the Decision Making and Cognition Laboratory in the Department of

Biomedical Informatics at Columbia University, has studied clinical reasoning and decision-making processes in health professions education for more than twenty-five years. Patel has reported the results of dozens of studies that investigated the thinking processes and information-seeking strategies of trainees and practicing health care professionals across a variety of medical problems and settings, including the public health arena, using sophisticated semantic and content analysis techniques employed in the disciplines of literary analysis, artificial intelligence, and cognitive science. A selected bibliography of ten of Patel's more than 100 publications in cognitive science and health professions education is indicated by references 27 and 82-91 including three studies recently published in the *Journal of Dental Education*.[27,82-91] Patel's body of research provides a reasonable best practices summary related to designing curriculum for the intertwined concepts of critical thinking and problem solving that lie between the more easily studied realms of declarative and procedural knowledge. Patel's findings can be summarized in two statements:

1. An effective process for development of the mental skills associated with clinical reasoning blends: a) initial acquisition of factual foundation knowledge (i.e., explicit, dial-up memory) in a traditional format that requires extensive reading of the literature and consistently employs in-class activity such as writing notes, analyzing problems, answering instructors' questions, and drill and practice testing, with b) case-based or issue-based seminars that allow students to clarify misconceptions and gain insight into the practical utility of foundation concepts by trying to apply them to problems. The case seminar component of a blended curriculum also allows trainees to have close contact and communication with faculty and practitioners, which provides opportunities for the modeling of expert thinking that appears to be a critical component of novice to expert maturation.
2. Trainees educated in the blended format described above do not make more accurate decisions than individuals trained in a purely classroom-based program, but they sample a wider variety of data sources, seek information from higher-quality and more desirable sources, have better understanding of the pathophysiological mechanisms (etiology) underlying diseases, and provide more sophisticated rationales and explanations for their decisions.

Conclusion

In one of his dialogues known as "Euthyphro," Plato described Socrates' method of teaching in which questions were posed to students and the students were forced to use their insight and logical reasoning to reach a conclusion, a technique that Plato described as conversational interaction.[92] Consistent with the perspectives of Socrates 2500 years ago, a review of the evidence indicates that several active learning strategies described in this article are associated with the development of the mental capacities needed for the expert practice of dentistry. These practices include:

1. In-class activity such as writing notes, analyzing problems, or reviewing cases that provide opportunities to apply the information being communicated;
2. Use of questions by instructors that require students to analyze problem etiology, compare alternative approaches, provide rationales for plans of action, and predict outcomes;
3. Frequent in-class quizzing with immediate feedback on response correctness;
4. Prospective simulations in which students perform decision making for structured and ill-structured problems;
5. Retrospective critique of cases in which decisions are reviewed to identify errors as well as exemplary performance;
6. Writing assignments that request students to analyze problems and discuss alternative theories about etiology, compare solutions, and defend decisions about proposed actions; and
7. Analyzing work products to compare how outcomes correspond to the best practice standards, including comparing the results of students' reasoning about problems to those of experts.

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