

ASPET TEACHING INSTITUTE

“Integrative Approach to Medical Education: Foundations, Methods and Outcome Assessment”

June 4, 2000

Boston, Massachusetts

Over the past 15 years, U.S. medical schools have critically examined the process by which we educate undergraduate medical students. This was prompted by the General Professional Education of Physicians [GPEP]¹ and the AAAMC-ACME-Tri² reports. Irrespective of the processes employed, the underlying philosophy of the various curricular revisions should be on how we can foster student learning that is directed towards the integration and application of basic science information as it pertains to the practice of medicine. Equally important is the design of assessment instruments to assure that this outcome is being achieved.

At 2000 ASPET Teaching Institute, the principles of cognitive learning theory, as they relate to the integration of preclinical sciences, were presented [Glenn Regehr]. Drawing on these fundamental tenets of cognitive psychology, both curricular and teaching strategies/methods promoting integrative learning [Kristi Ferguson, Jack Strandhoy, George Dunaway] and assessment methods [Peter Harasym, Charles Eldridge, Craig Davis] consonant with the goal of student learning directed towards application and integration of information, were offered.

Cognitive Psychology: The Basic Science of Education, Glenn Regehr, Ph.D., Centre for Research in Education at the University Health Network, University of Toronto Faculty of Medicine.

To properly understand effective educational practice we must understand something about how the human learner functions. One aspect of the “basic science” of learning is

MEMORY. This presentation will attempt to provide a set of “facts” about the nature of human learning, and I will try to tie these facts into a framework of what good educational practice might entail.

The human memory system is amazingly powerful and flexible. As a brief example of this power, consider the following questions: In what year did Columbus discover America? What is the square root of 144? What is your mother’s maiden name? What is the definition of a noun? In what year did you obtain your last degree? What did you eat for dinner last night? For many people, the answers to these questions arise from memory with little or no effort despite the fact that several of the questions have not been considered for years or even decades. Again, this is just a quick demonstration of the fast and effective and easy retrieval of information long unused. However, this demonstration of the power of memory might lead educators to wonder why students seem to have such difficulty remembering the information they are taught at the times when they need it most.

The answer to this dilemma is that the memory system is powerful, but also has a set of clear limitations. The system is not infinitely flexible or powerful. Rather, it functions extremely well within a specific set of parameters. Effective teaching involves understanding these parameters of operation so that we can avoid violating them and can use them to maximize effective learning. This presentation briefly presents and describes three of these parameters: Meaning, Encoding Specificity, and Practice.

Meaning

It is far easier to learn and remember meaningful information than meaningless information. As a quick example, compare the effort required to memorize the letters in the phrase, “The quick brown fox jumped over the lazy dog” and the same letters rearranged in a meaningless pattern, “dfjloqbttoouavuhrhgxmzeieoepyrckwkd.” However, it is important to note that meaning is in the eye of the beholder. The first organization of the letters is only helpful for an English speaking person. Similarly, research suggests that an expert internist will have much better memory for a set of numbers associated with a patient’s blood gases than will a medical student who does not know how to impose meaning on the numbers. Interestingly, if there is no meaning for the learner, often he will invent some arbitrary meaning that help him to remember. Thus, often learners will invent a phrase with the first letter of each word in the phrase representing the first letter of a list of names to be remembered [for example, the phrase, “some lovers try positions that they can’t handle” represents the first letter of each of the bones of the hand]. These arbitrary memory devices are referred to as mnemonics. While these mnemonics are useful in the short term, however, the form of the meaning is not relevant to how the information will be used later, and therefore is limited in its long term usefulness [I can remember the phrase, for example, but no longer know the names of the bones that the phrase refers to]. A more useful method of imposing meaning, therefore, would be to impose the meaning that is available to the expert (or at least a reasonable

approximation of that meaning as a first pass). Thus, it becomes the responsibility of the effective teacher to provide USEFUL meaning for the learner. This form of meaning is often in the form of metaphors or analogies [“the heart is like a pump”], using previous knowledge and understanding in the learner to generate appropriate meaning for the new information.

Encoding Specificity

Where, how and why the information is encoded affects where, how and why, it is later retrieved and used. Let's take each of these in turn. First, *where* we learn affects where we will later be able to remember. Almost everyone has had the experience of leaving their office to do something, getting part way down the hallway and forgetting why they left the office. Ironically, when we finally give up trying to remember and return to our office, we almost immediately remember why we left it in the first place. Again, the location of where we first generated the idea or first learned the information seems to have special status as a place for remembering that idea or information. This phenomenon is often referred to as context specificity [the context where you can remember something is specific to the context where you learned it]. Second, **how** we learn something affects how we can later retrieve it. As a quick example, trying to recite the months of the year alphabetically takes a huge effort because this is not how the information was originally encoded. If it goes in temporally it comes out temporally. To make it come out alphabetically is much more difficult. Practically, this is why students want to know whether the test will be multiple choice or short answer. How they have to retrieve the information actually affects how they will study for the test. This concept of encoding specificity has

important implications for learning. This is why the arbitrary meaning imposed by mnemonics is relatively helpful for the written test, but relatively unhelpful for the clinical setting. Thus, the lack of transfer from the classroom to the clinic is NOT just because students are learning the “wrong” things or in the “wrong” place. Rather, they are learning in a different way that is highly functional for their immediate needs [studying to the test]. Generating transfer of the knowledge to other situations, contexts and uses requires planning those situations, contexts and uses.

Practice

The phrase “practice makes perfect” is as true for memory as it is for any other performance task. Time spent on study directly related to performance on examinations. This is not very surprising to anyone. However, there are several caveats to this effect of practice. First, it is important to be aware that the effect of practice is very specific. That is, practice in the retrieval of a given piece of information makes retrieving that piece of information easier. Additional practice does not create a generic “better memory” skill. Second, it is important to distinguish between retrieval and rehearsal. Simply repeating a name over and over in your short term memory is NOT helping you to remember it. Practicing bringing it back to short term memory from long term memory is the practice that must be performed if you wish to make it easier to bring it back from long term memory when you really need it. Third, there is an important distinction between cued and uncued retrieval. This harkens back to the discussion of encoding specificity. If you wish to remember something out of the blue when it is needed, you must practice retrieving it spontaneously at times when no other cues are available. Thus, for teachers,

testing material from a previous chapter [or previous course] is not “cheating”; it is sound educational practice!

Implications for Education

These parameters of the memory system have important implications for effective teaching and learning. In short, the effective teaching of material to be used appropriately at a later time requires:

- Helping the learner to impose appropriately meaningful structure on the information
- Ensuring that the nature of the meaning and the structure of the information is consistent with the later uses of the information
- Providing opportunities for practice at retrieving and using the information at greater and greater intervals in a variety of contexts

Concept Maps: An Educational Method to Help Students Integrate Material, Kristi J. Ferguson, Ph.D., Office of Consultation and Research in Medical Education, University of Iowa College of Medicine.

Purpose. The purpose of concept maps in teaching medical students is to help students see how underlying mechanisms relate to symptoms, diagnosis, treatment, and prevention. A concept map is a 2-dimensional diagram depicting the relationships between concepts. Concepts are placed in “nodes” and linked together with lines that are sometimes labeled to indicate the type of relationship.

Rationale. Concept maps are useful because they help learners organize information visually, help learners reduce verbatim retention, and reduce need for rote learning.

Mechanisms. Concept maps accomplish these goals because they

require learners to retrieve prior knowledge and to integrate new information. In addition, concept maps facilitate transfer to long-term memory and enhance transfer to problem-solving activities.

Uses. Overall, concept maps can be used to generate ideas, explicitly analyze ideas & relationships, communicate complex ideas & relationships, and represent, convey, and construct knowledge structures that enable understanding. When used for instruction, concept maps can be drawn by the instructor to show students how concepts relate to each other. Or they can be drawn by students either as individuals or in group to achieve a deeper understanding of concepts being studied. When used for assessment, concept maps can be used to quickly identify students' misconceptions and thereby guide further instruction, or they can be used in a formal way to assess students' understanding of the material.

Process. There are several steps involved in constructing a map. First, select key concepts that will be included. It is generally recommended that concepts be general, using sub-maps to expand as needed. Second, decide the most important concept and look at its relationships with other concepts [e.g., hierarchical, vertical or horizontal]. Next, construct the map. One strategy is to put each concept on a note card so it is easy to rearrange them or use removable notes attached to a large sheet of paper. Once concepts have been arranged in an initial map, look for cross links and choose linking words. If appropriate, add arrows indicating directionality of relationships. Finally, compare maps or discuss the map with someone who was not involved in the process of constructing the map and reconstruct the map if needed [it often is revised following discussion].

The University of Iowa College of Medicine uses concept maps in several ways. First, case-based learning [CBL] groups use concept maps to summarize each case. Second, content experts are asked to develop a map that students and facilitators can use as a reference. Third, individual students have been asked to develop a map for the case and then compare the map to those developed by others in the group. Finally, we have suggested that students from different groups work together, which has proven to be a very effective learning device for students.

Summary. In summary, concept maps are an effective device for integration. They can be used in different ways, to serve different purposes. Finally, the process to develop maps seems simple, but to be an effective teaching and learning tool requires practice on the part of concept map developers. [Note: Sample maps are available at <http://www.medicine.uiowa.edu/ocrme> in the faculty development section under "teaching tips"].

Integrating Curricular Goals and Teaching Methods, Jack W. Strandhoy, Ph.D., Department of Physiology and Pharmacology, Wake Forest University School of Medicine.

If you know where you want to go, you're more likely to get there. Wake Forest University, like most medical schools, has defined educational goals and objectives. While goals [the desired product] and objectives [testable endpoints] may be similar between institutions, the methods by which the goals are achieved vary considerably. We reported in this Institute on our Prescription for Excellence curriculum and how our methods relate to the seven educational goals established by the faculty.

These goals include:

1. Self-directed learning and life-long learning skills
2. Core biomedical science knowledge
3. Interviewing and communication skills
4. Clinical skills
5. Problem solving and clinical reasoning skills
6. Information management skills
7. Professional attitudes and behaviors

New methods were purposely incorporated into our curriculum to address each of the educational goals. The structure of the curriculum was presented to demonstrate how these methods were incorporated into a typical week. The curriculum uses an increased number of small group case discussions; protected time for independent learning; research, and clinical experiences; standardized patient examinations, courses in epidemiology, evidence based medicine, and ethical issues; and computerization throughout all four years. The challenges specific to a discipline such as pharmacology in an integrated approach were addressed. When active, independent learning supplants many lectures, lectures may still remain the best format to introduce principles [e.g., pharmacokinetics], present complex topics [ANS/CNS pharmacology principles], provide the "big picture" in complex pharmacotherapy [hypertension], or discuss integrated pharmacotherapy requiring many drug categories [cancer]. Another concern in such a curriculum is the ability to monitor which topics are presented in other than lecture format. We are in the preliminary stages of identifying these activities by coding with the USMLE content outline codes. This will make it possible for students or faculty to retrieve most learning activities that have been identified for each topic.

Models for Integration of Pharmacology with the Basic and Clinical Science Disciplines Taught During the Second Year Medical Curriculum, George A. Dunaway and Carl Faingold, Department of Pharmacology, Southern Illinois University School of Medicine.

This presentation described the efforts by the authors to integrate endocrine and central nervous system pharmacology learning issues into multidisciplinary integrated sessions involving the basic and clinical sciences, which are traditionally part of the second year medical school curriculum. The authors identified key steps in the process, i.e., development of team leadership and members, use of learning issues from each discipline to design cases, session structure and design, mechanics of session delivery, test design using case vignettes with associated multidisciplinary questions, basis of promotion decisions, and mechanisms for obtaining and utilizing student opinion. A common element in each session was the use of clinical case vignettes, which were chosen to address important disease types and learning issues in each discipline. Most sessions integrated Pathology, Pharmacology and Internal Medicine, and single discipline sessions were used to introduce discipline-unique material. Educational materials for each session were made available in advance to the students with the expectation of preparation prior to class. The educational material from each discipline included modules, which presented learning issues and reading resources, a list of the cases for each session, and a printout of slides. Sessions began with a brief review of a paper case by a physician or pathologist who described presenting symptoms, patient history, and physical examination. Hypotheses were developed and used as ratio-

nale for tests ordered. After interpretation of test results, a differential diagnosis and the classification of the types of the particular class of disorder were discussed. A pathologist presented the pathophysiology of the disease using both gross tissue samples and tissue section histochemistry. Then the pharmacology of the drugs to treat this disorder was presented, utilizing the Pharmacology Mental Algorithm, a systematic and rational approach to drug therapy. The session was completed by a clinician who added further clinically relevant information, i.e., choice of treatment based on patient health, short and long term management of the disease, and clinical pharmacology. The endocrine sessions also included a requirement for each student to participate in the Endocrine Clinic. The CNS block, which was a longer session and involved more faculty, also included clinical skill sessions and simulated or fixed finding patient experiences, which were followed with small group sessions that were organized by participating physician faculty. Students were tested using integrated evaluations that were based on case vignettes with multiple choice questions provided by each discipline. The goal of the examination was to evaluate knowledge base in the discipline areas and its application to clinical problem solving. A practical evaluation of each student's patient examination skills was also performed by clinicians, and acquisition of basic clinical skills was required. Feedback from the students on the organ system activities was obtained using a standard questionnaire. The results of these surveys suggest a high degree of attendance, satisfaction and confidence. The authors indicated that development and implementation of these sessions requires the support of the administration at all levels, faculty leadership and participation, and a considerable amount of time

to organize, improve and update. Use of multidisciplinary sessions largely eliminated redundancy and confusion related to different terminologies among disciplines. The pace of the sessions was determined by student involvement and allowed the amount of time on each subject matter to be dictated by student comprehension and interest. These sessions broadened faculty knowledge and improved faculty relationships.

Challenging Students to Critically Appraise Basic Science Information in an Integrated Medical Curriculum, Peter H. Harasym, Ph.D., Department of Community Health Science, Office of Medical Education, University of Calgary Faculty of Medicine

The medical school-learning environment must foster integration, challenge students to think critically, and evaluate students' growth towards professional competence. Central to this learning environment are the curricular model and quality of student assessments used.

The type of curricular model will determine the degree of integration between the basic and clinical sciences³. For example, the 1765 Apprenticeship-based model focused on clinical problems with little integration. The 1871 Discipline-based model clearly separated basic and clinical teaching without any integration. The 1951 System-based model was the first attempt at integrating the basic and clinical sciences, but the results were more interdigitation than integration. The 1971 Problem-based model was the first curriculum in which true integration occurred [i.e., through small groups, students learned both the relevant basic and clinical information needed to resolve patient problems]. And, the most

recent 1991 clinical presentation-based model also provides a true platform for the integration of the basic and clinical sciences⁴. However, the first four curricular models were based on the false assumption that clinical problem solving was due to a single generic cognitive process known as hypothetical deductive reasoning. Several research studies have shown that problem solving is “case specific” [i.e., highly dependent on the availability of knowledge relevant to the specific clinical problem]^{5,6}. The clinical presentation-based curriculum is the first model that incorporates the research findings that there is a unique problem-solving scheme for each patient presentation⁴. This model presents students with a scheme or road map to guide both the learning of the relevant basic and clinical sciences and a strategy for discriminating one disease from another. This method of learning is referred to as the “broad picture” approach [i.e., the overview that guides problem solving is also to guide student learning of both basic and clinical science knowledge]. This method is in sharp contrast to the “bottom-up” approach of the disciplinary model. The bottom up approach inappropriately has students learn and apply the scientific hypothetical-deductive reasoning process to diagnose and treat patient problems³.

Student assessment is the second component that is important in creating an optimal learning environment. Good assessment growth will guide students in their quest towards clinical competence. One model divides clinical competence into the four hierarchical layers of knows, knows how, shows how, and does⁷. The first two levels of “knows” and “knows how” reflect understanding [i.e., is cognitive in nature]. The top two levels of “shows how” and “does” reflect observable behaviors

within the practice of medicine. As one moves up the four levels from “knows” to “does,” one increases professional authenticity. The lowest level of “knows” is measured by factual and comprehensive pencil and paper tests using primarily MCQ, essay, and short answer formats. The second level of “knows how” is also measured by pencil and paper using primarily the same formats. However, all questions in the “knows how” category are based on clinical cases [low fidelity challenges]. The third level of “shows how” is measured by performance tests *in vitro* by OSCEs and standardized patients [high fidelity challenges]. The fourth level of “does” is measured by performance tests *in vivo* by such methods as undercover standardized patients, videos, and patient records. It is recommended that at the undergraduate level, the evaluation of students should concentrate at the two middle levels of “knows how” and “shows how.” Thus, examinees should primarily face clinical problem solving, paper and pencil questions, OSCEs, and SPs on undergraduate certifying examinations. Since what is on the exam drives student learning, it is important that the questions and tasks given to students are within a clinical context at the “knows how” and “shows how” levels. Too often, the majority of questions given to students assess factual recall and comprehension at the lowest level of “knows.”

In writing quality MCQs, it is important to know that the stem of the item determines the mental challenge (i.e., cognitive level) and its alternatives determine the difficulty level [i.e., how many students get the item correct]. “What is the population of the inner city of Boston?” This is a factual recall question. The number of students who get this question correct will be determined by the alternatives

provided. For example, in a list of alternatives that increase in increments of 0.5 million [e.g., 0.5, 1.0, 1.5, 2.0, 2.5 million], more students are likely to get the item correct than if the alternatives increase by very small increments [e.g., 0.534, 0.554, 0.574, 0.594, 0.614 million]. In other words, the closer the alternatives are together, the more difficult the item and the fewer the number of students who will get the correct answer. If the item writer were to alter the nature of the question in the stem to “What will be the population of the inner city of Boston in 2010?” the challenge of the question is changed from the lower level of recall to a higher level of problem solving. Another basic principle of MCQs is to maximize its discrimination ability. This is the ability of a question to separate the top from the bottom performing students. Swanson and Case [1996] reported a study that examined the effect of three types of MCQ stems [independent variable] on item difficulty and discrimination [dependent variables]. They compared the effect of no vignette, short vignette, and long vignette on the question’s ability to discriminate between good and poor students and found that the long vignettes had the greatest discriminating effect. That is, the good students did well on whatever type of stem was used, but the poor student’s performance declined as the length of the vignette increased to include both relevant and irrelevant clinical information. Thus, item discrimination can be improved by using long case vignettes. Finally, there are several types of MCQ formats that can be used to assess students depending upon the objective measured [type A, X, and R]. Type A asks the student to select the single best [e.g., Mr. Morrissey has what type of edema?]. Type X asks the student to select all the true statements [e.g., What factor[s] is/are responsible for Mr. Morrissey’s

edema?]. Type R gives the student 15-25 alternatives [e.g., diagnoses, treatment, or microorganism], 3 - 6 clinical vignettes, and asks the student to select the most appropriate alternative for each clinical vignette. For more details on writing quality MCQs in both basic and clinical sciences, see item-writing manual at <http://www.nbme.org/new.version/item.htm>.

In conclusion, the type of curricular model determines the degree of integration between basic and clinical sciences. Learning and evaluation should be based on the students' integration of clinical and basic sciences [broad picture approach]. Assessment drives learning. Central to the educational environment are the challenges presented to the students. Examination should focus on assessing "knows how" and "shows how." The question in the stem of the item determines the mental task, and the closeness of the alternatives in turn determines the difficult level. Using long clinical vignettes can enhance integration, discrimination, and validity. There are multiple techniques and formats that challenge students' ability to utilize basic and clinical knowledge [i.e., type A, X, and R]. In summary, learning will be enhanced if the environment challenges students to integrate relevant clinical and basic science information and encourages them to be deep thinkers [i.e., to think critically].

Assessment of Pharmacology Issues in an Integrated Medical Curriculum, J. Charles Eldridge, Ph.D., Department of Physiology and Pharmacology, Wake Forest University School of Medicine.

The Wake Forest School of Medicine is about to enter the third year of a substantially revamped medical curriculum called "A Prescription for Excellence: A Physician's Guide to Lifelong Learn-

ing." During the first two years, students use laptop computers that connect to a server and network-based distribution of all curricular materials. Program integration was achieved by emphasizing a profession-based nature of the curriculum, i.e., by focused learning and training in a professional environment of clinical settings, and by applying basic information to the practice of medicine at every step.

Beginning with the first week, students learn physical exam skills; examine detailed case scenarios in small groups for appropriate, self-directed study of basic science learning issues; and engage in sessions in professionalism and critical reading of medical literature. In basic science study, a phase emphasizing human structure [anatomy, histology, embryology, radiology] is followed by a phase emphasizing cellular mechanisms [biochemistry, metabolism, molecular biology, immunology, infection]. The remainder of the first two years follows a systems-based tour of physiology and pathophysiology. Pharmacology, being essentially a second-level application of physiology and biochemistry toward a therapeutic goal, is interwoven throughout the entire 2-year program. In keeping with the professional design, pharmacology is taught in the manner in which physicians use the knowledge, and it is then tested in the format in which it was taught.

Among examples of the new design: lecturers in pharmacology-related topics, using PowerPoint image sets the students can download, are required to connect the principles being explained with their respective professional applications, and to provide sample questions. Therapeutic issues in each weekly case that lead to self-study of pharmacology are also tested on block exams, but in the format presented

[case-related problem followed by choices]. In addition, at three points during the first 2 years, each student examines a simulated patient case, studies appropriate material on his/her own, and returns for an oral or written essay exam. Pharmacology-related questions, particularly those covering mechanisms of therapeutics, are frequently covered in these oral and written exams.

To promote effective instruction even further, a curriculum-wide committee on evaluations has been implemented. Each course and theme director must present a detailed plan for student assessment and grading. The committee helps each director work toward the established universal goals of clearly presented course objectives, experience with self-directed learning, integrated learning in a professional context, and measurable reliability and validity of the evaluation process.

In summary, the new Wake Forest medical curriculum has adopted new strategies and modes of instruction. Material is taught more in the manner in which it will be used, than as an isolated academic subject. Concepts for learning are generated from specific examples, rather than by the traditional approach of teaching principles before examples. For these students of a profession, the initial encounter of a specific problem creates a thirst to synthesize the strategy for solution. Testing is conducted in the manner of the instruction, i.e., case-based, problem-based, emphasizing comprehension and application of knowledge. Pharmacology is studied as a strategic means to an end, and it is tested in the same manner. Students and faculty are more comfortable with this approach because they prefer investigation of principles underlying therapeutic strategy over memorization of drug names and actions.

Integrative Knowledge Assessment Using Multiple Choice Questions,
Craig W. Davis, Ph.D., Department of Pharmacology and Physiology, University of South Carolina School of Medicine.

Improvements in the quality of undergraduate medical education have emphasized the need to foster the development of problem-solving skills in the student. The various curricular designs/approaches which were presented at the Institute provide the requisite ‘input’ for students to recognize both the importance and the development of integrative learning behavior. Student assessment [‘output’] is the measurement of the success of the curriculum in achieving this outcome. Since it is recognized that assessment drives student learning behavior, it is of paramount importance that any instrument for assessing a student’s knowledge and understanding of the basic sciences be consistent with the goals of an integrative curriculum. Traditional assessment is rooted in rote recall of information fostering a surface/instrumental learning style and a more rigid compartmentalization of knowledge. This method should be replaced with assessment aimed at integration, interpretation and application of information which fosters a strategic/conceptual learning style and a more fluid knowledge base.⁹ The use of multiple-choice questions [MCQs] aimed at the integrative assessment of a student’s knowledge was presented at the Institute and included the following three major areas of consideration:

1. The nature of MCQs which assess integrative learning.
2. Approaches to the design of MCQs to assess integrative learning.
3. Caveats and suggestions related to the use and design of MCQs to assess integrative learning.

Discipline-specific and multi-disciplinary integrative MCQs were illustrated showing the various formats [e.g., clinical vignettes, interpretation and analysis of data from figures, diagrams and graphs, patient profiles, etc] to assess a student’s problem-solving skills. The complexity of these MCQs rests in the stem while the difficulty is determined by the nature of the lead-in and option foils. A rote MCQ asking a side-effect [SIADH] associated with a drug [carbamazepine] treatment for a given illness [bipolar disorder] is transformed into an integrative question by describing the clinical presentation of both the side-effect and the disease for which the patient is being treated. The student can then be asked to identify the drug, a mechanism responsible for the presentation, etc. In such questions, you are asking the student to retrieve information obtained in other courses or at some time earlier in the same course. Such an approach [i] reinforces learning behavior aimed at the integration/application of current information and, [ii] increases the awareness that one’s knowledge base is cumulative, i.e. a student is not “immunized” from studying and being tested on prior information.

The use of concept or knowledge mapping and the development of therapeutic algorithms for the design of these MCQs was presented. Concept maps are diagrammatic representations of meaningful relationships between concepts.¹⁰ They provide both the student and faculty member a “guide” to the key ideas important for higher level reasoning and are useful in teaching, learning, curricular development and assessment. An example is the treatment of arthritis where the mapping systematically integrates the pathology/pathophysiology, biochemistry, and pharmacology associated with common arthritic presentations [RA, OA and gouty].

From this, a therapeutic algorithm for each arthritic condition can be developed for use in creating vignette-style MCQs. A typical vignette would describe an arthritic presentation [symptoms, laboratory/radiological findings] coupled with preexisting medical history [aspirin allergy, renal dysfunction, bleeding diathesis]. The lead-in could then ask to select the most appropriate therapy, the rationale for most appropriate therapy [i.e., mechanism of action], side-effects associated with the most appropriate therapy, etc. In a clinically relevant context, you are simultaneously assessing the student’s understanding of pathology [i.e., a correct differential diagnosis] and differences in the basic pharmacology of agents employed for treating such disorders [i.e., side-effect profiles, differences in mechanism, etc].

In considering the development and use of MCQs for integrative knowledge assessment, a few suggestions / caveats which may be helpful:

1. The assessment should be in a context related to the skills and attitudes of the student learner [i.e., meaningful]. For multi-disciplinary assessment, the nature and extent of integration is dictated by the temporal sequence of curricular disciplines. In discipline-based assessment, the course must be internally integrated, and the assessment should be progressively comprehensive.
2. Anticipate a significant time commitment to developing these questions. In developing a question bank, optimization of effort can be achieved through [i] subtle modification of the stem and [ii] variations in the lead-in.
3. In preclinical assessment, avoid the use of “window-dressing” / “red-herrings” in the stem and development of rote questions cloaked in clinical vernacular.

4. Establish measures to optimize the probability of student success [e.g., provide sample questions with explanations; employ content relevant and integrative instruction techniques; etc.].

References

1. Muller, S. [1984] Physicians for the Twenty-First Century: Report of the Project Panel on the General Professional Education of the Physician [GPEP] and College Preparation for Medicine. *J. Med. Educ.* **59**, Part 2.
2. ACME-TRI Report: Educating Medical Students [1992]. Association of American Medical Colleges [AAMC].
3. Papa, F. J., & Harasym, P.H. [1999]. Medical Curriculum Reform in North America, 1765 to the Present: A Cognitive Science Perspective, *Acad. Med.*, **74**:154-165.
4. Mandin H., Harasym P., Eagle C., Watanabe M. [1995] Developing a "Clinical Presentation Curriculum at the University of Calgary. *Acad Med.*, **70**:186-193.
5. Elstein A.S., Shulman L.S., Sprafka S.A. [1978] Medical Problem Solving. An Analysis of Clinical Reasoning. Cambridge, MA/ London, U.K.:Harvard University Press.
6. Neufeld V.R., Norman G.R., Feightner J.W., Barrows H.S. [1981] Clinical Problem Solving by Medical Students: A Cross-Sectional and Longitudinal Analysis. *Med Educ.*, **15**:315-22.
7. Miller, G.E. [1990]: The Assessment of Clinical Skills/Competence/ Performance. *Acad. Med.*, **65**:S63-S67.
8. Case, S.M., Swanson, D.B., and Becker, D.F. [1996]. Verbosity, Window dressing, and Red Herrings: Do They Make a Better Test Item? *Acad. Med.*, **71**:S28-S30.

9. Davis, C.W. and Allen, D.O. [1999]. Assessment in Medical Pharmacology: Designing MCQs to Assess a Student's Type-1 Problem-Solving Skills, *The Pharmacologist*, **41**[3]:107-113.
10. Novak, J.D. and Gowin, D.B. [1984]. Learning How to Learn. Cambridge, Cambridge University Press.



Speaker Peter Harasym and Organizer/Speaker Craig Davis going over last minute details before the Teaching Institute.



Speaker George Dunaway (right) discusses his presentations with an attendee at the Teaching Institute.



Speaker Glenn Regebr makes his presentation at the Teaching Institute.



Speaker Glenn Regebr (left) discusses his presentation with Frank Vincenzi and Ralph Purdy.



Speakers Charles Eldridge and Jack Strandhoy (from left) listen to the presentation of another speaker during the Teaching Institute.



Plans for the next Teaching Institute and Graduate Student Convocation are discussed by (from left) Jerry Buccafusco, Bob Gussin, Jim Gibb, Ron Shebuski, and Dave Taylor.