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Peer Review (ISSN-1541-1389) is published quarterly by the Association of American Colleges and Universities, 1818 R Street, NW, Washington, DC 20009-1604. Annual rates are $35 for individual subscriber and $45 for libraries. Periodicals postage paid at Washington, DC, and at additional mailing offices. Copyright 2012. All rights reserved. POSTMASTER: Send address changes to: Peer Review, 1818 R Street, NW, Washington, DC 20009-1604.
In this issue of Peer Review, produced with generous support from the Howard Hughes Medical Institute, we feature articles representing a range of experiences—medical educators, dental educators, health advisors, social scientists, and foundation professionals—and address the significance of the Medical College Admissions Test (MCAT) changes in the undergraduate curriculum for future physicians.

American Association of Medical Colleges (AAMC) president and CEO Darrell Kirch recently commented on the upcoming changes to the MCAT. He noted, “Being a good doctor is about more than scientific knowledge. It also requires an understanding of people. By balancing the MCAT exam’s focus on the natural sciences with a new section on the psychological, social, and biological foundations of behavior, the new exam will better prepare students to build strong knowledge of the socio-cultural and behavioral determinants of health.”

Everyone has his or her own idea of what the traits of a “good doctor” are, but to get a better sense of what research says on this topic, I consulted an article titled “What Patients Want: A Content Analysis of Key Qualities that Influence Patient Satisfaction,” published in the March/April 2007 issue of Medical Practice Management. The authors write about an online survey in which patients reflected on experiences with their personal physicians. These survey results revealed that, “Patients value factors such as access, engagement, and personal attention,” in addition to technical expertise. The article summarized the results by noting that “a practical use of these findings would be more emphasis in physician training ... in developing skills that can result in clearly communicating, expressing empathy, and supporting patient information needs.”

The Journal of the American Medical Association (JAMA) also champions development of these broader skills sets by including two distinctive features. First, in addition to the inclusion of many cutting-edge, research-based articles that the journal is known for, in every issue they also publish first-person essays in a department called “A Piece of My Mind.” These essays—written mostly by physicians, but also by other health care professionals and patients—offer insight into the daily experiences and relationships of those in the medical world. JAMA also includes a reproduction of a piece of fine art on every cover and an essay that reflects on that artwork inside the journal. In expressing why fine art is appropriate for the cover of a medical journal, M. Therese Southgate, a physician and editor who for more than two decades chose the artwork and crafted the accompanying essays, wrote, “Both medicine and art are about seeing, first with the eyes of the body, but if one is attentive enough, then with the eyes of the mind and of the heart.”

Former JAMA editor George Lundberg wrote that one of his journal’s objectives is to “inform readers about nonclinical aspects of medicine and public health. ... Our JAMA art covers and cover stories help us meet that objective every week. In fact, they formed the beginning of our whole JAMA initiative to emphasize the humanities in medicine.” JAMA clearly values the humanistic aspects of medicine. Ideally, the new MCAT changes will assist in admitting medical students who not only have strong scientific knowledge, but who also appreciate the rich physician–patient engagement celebrated by the journal.

In addition to bringing more balanced candidates to medical training, the undergraduate curriculum changes suggested by the new MCAT reflect the type of integrative thinking that AAC&U recommends for all undergraduate students. In this issue, AAC&U announces the new Scientific Thinking and Integrative Reasoning Skills (STIRS) project, which builds on AAMC’s new Science and Reasoning Skills (SIRS) framework. The AAC&U STIRS project aims to ensure that college graduates can use scientific reasoning to gather and evaluate evidence, understand how scientific and social scientific studies are designed and executed, use statistical reasoning to evaluate data, use data to communicate effectively, and base decisions on analysis of evidence, logic, and ethics. Through this project, AAC&U seeks to prioritize attention to scientific thinking and integrative reasoning in the national conversation about general education and liberal learning.

Developing the STIRS capacities is certainly mandatory for our future physicians, but achievement of them is also desirable for students of all majors. As AAC&U leaders have argued since the launch of the LEAP initiative, integrative reasoning is the twenty-first-century liberal art.

—SHELLEY JOHNSON CAREY

We gratefully acknowledge this issue’s editorial planning committee members—Kenneth C. Burris, Susan Elrod, Robert C. Hilborn, Kevin Hosland, and Richard K. Riegelman—for their work in developing the following content on implications for the upcoming MCAT changes.
Scientific Thinking, Integrative Reasoning Skills, and the New MCAT

Carol Geary Schneider, president, AAC&U

This issue of Peer Review reflects the vision and efforts of several colleagues who recognized that AAC&U members would be eager to learn more about the significant changes in the design of the Medical College Admission Test (MCAT). With the generous support of the Howard Hughes Medical Institute, we have been able to commission an interesting and timely collection of articles; we have also been given the opportunity to reach beyond our normal circles and engage a broader audience of educators who have not, perhaps, had regular occasion to think about the connections among preparation for graduate education, employment in a wide variety of health professions, and the current state of undergraduate liberal education.

Significant changes in the MCAT were announced at the Association of American Medical Colleges (AAMC) annual meeting in November 2011 and were finalized by the AAMC Board of Directors in February 2012. Among the review committee recommendations are to

- Add biochemistry to the physics and chemistry component of the examination
- Add cellular and molecular biology to the biology examination
- Add a behavioral and social sciences component—tentatively called the Psychological, Social, and Biological Foundations of Behavior
- Integrate a new Scientific Inquiry and Reasoning Skills (SIRS) framework into the two natural sciences components as well as the new behavioral and social sciences component

More broadly, the review committee recommends that the MCAT focus more on learning outcomes and competencies than on specific course content. In fact, even as they recommend that new subject areas be included in the examination, the committee does not recommend increasing the number of credit hours that students need to complete.

These changes in the MCAT reinforce for the authors in this issue and for AAC&U an already urgent need for significant curricular revision in these fields, especially to focus more on competencies within lower-division prehealth coursework. The authors suggest strongly that the MCAT revision marks a once-in-a-generation opportunity to break through some of the disciplinary rigidity that has come to characterize prehealth education—a rigidity that has been linked to high levels of attrition from science courses/departments and to complaints by graduate programs that undergraduate students have not been encouraged to make creative connections between and across disciplines and divisions.

In the context of health professions and the study of issues related to health, in particular, such graduates need to be able to

- Use scientific reasoning to gather and evaluate evidence
- Understand how scientific and social science studies are designed and executed and recognize the implications of design choices

It is critical that we underscore the connections between the full range of the liberal arts and sciences and students’ capacities to make reasoned judgments about public issues.
Use statistical reasoning to evaluate data and use data to communicate effectively.

Base decisions on analysis of evidence, logic, and ethics.

AAC&U is delighted to announce a new project that targets these skills. Expanding on AAMC’s new SIRS framework, AAC&U’s Scientific Thinking and Integrative Reasoning Skills (STIRS) project will help leaders across all sectors of higher education foster scientific thinking as a way to intentionally integrate knowledge, skills, and action across the undergraduate experience and through the widest array of disciplines. Over the course of the next two years, the STIRS framework will inform a national conversation and will provide coherence to the development of case studies, course modules, sample first-year seminars, integrative learning assignments, and other curricular models that integrate evidence-based thinking across general education and into the major. These resources will be developed and tested at all types of institutions, peer reviewed, and shared nationally through AAC&U’s meetings and publications. STIRS Scholars—named and rewarded for excellence in this important curricular arena—will provide additional leadership to an emerging community of practice. Please see Richard Riegelman’s article on page 10 of this issue for additional details of the STIRS project. STIRS will be led by staff in AAC&U’s Office of Integrative Liberal Learning and the Global Commons; to get involved, please contact Kevin Hovland at hovland@aacu.org.

I would like to conclude by situating this project in the context of some broad observations I made during recent strategic planning conversations across AAC&U and PKAL.

Many of the changes AAC&U seeks to advance (for example, more intentional, integrative learning; hands-on, problem-centered inquiry and research; and global, civic and ethical responsibility) can be effectively illustrated in the context of STEM teaching and learning. The MCAT revision is an important example in an arena widely seen as crucial to America’s future. We should take advantage of all such opportunities to make STEM a exemplary site for demonstrating the value of liberal education to professional excellence.

Even as STEM and medical education are the focus of intense reform attention, the assault on the humanities and many of the social sciences continues apace. It is critical that we underscore the connections between the full range of the liberal arts and sciences and students’ capacities to make reasoned judgments about public issues. I sincerely hope that AAC&U’s STIRS project will be the first of many proactive efforts to revitalize the liberal arts and sciences disciplines, both as fields of study and as component elements in general education.

AAC&U’s vision for robust liberal education, civic learning, global learning, and STEM learning requires a coherent and vibrant general education. While that is not the primary goal of the MCAT revisions, it is a fundamental aim of the STIRS project. I hope that such efforts will encourage the new leadership we need to advance twenty-first-century designs for general education and to connect those designs with civic learning, global acumen, STEM proficiency, and illustrative problems we face as a society. Certainly, without strong foundations in scientific thinking and evidence-based reasoning, such designs will not be successful.

Time will tell if revision of the MCAT does, in fact, represent a once-in-a-generation opportunity. We can neither afford to waste any opportunity to improve undergraduate learning, nor view this opportunity as limited to certain disciplines or majors. Instead, we should recognize the common purpose that connects myriad generative and transformative change efforts I see every day as I visit AAC&U member campuses and attend meetings and conferences—efforts to create undergraduate learning opportunities that more closely match the complexity of big questions and the urgency of today’s challenges.
Undergraduate Preparation for the Health Professions and the Revised Medical College Admissions Test

Robert C. Hilborn, associate executive officer, American Association of Physics Teachers
Catherine R. Lucey, professor of medicine and vice dean for education, University of California, San Francisco School of Medicine
Richard K. Riegelman, professor and founding dean, School of Public Health and Health Services, The George Washington University

In 2009, a joint committee of the Howard Hughes Medical Institute (HHMI) and the Association of American Medical Colleges (AAMC) released the report Scientific Foundations for Future Physicians (SFFP) (AAMC–HHMI Joint Committee 2009). The SFFP report focused on the natural science and quantitative “competencies” needed for the preparation of successful physicians. The report included recommendations for both undergraduate preparation in the natural sciences and mathematics for medical school and for medical education itself. The SFFP report was used to guide the review and revision of the Medical College Admission Test (MCAT) by AAMC’s MR5 Committee. The AAMC adopted the recommendations of the MR5 Committee in February, 2012.

The SFFP report explicitly framed its arguments in terms of what knowledge and skills students should acquire in the natural sciences and mathematics and what they should be able to do with that knowledge and those skills—in short, the competencies that students should be prepared to demonstrate if they are to be successful physicians. The focus on competencies as a method of articulating student preparation was made intentionally. Colleges, universities, and medical schools should be able to be innovative in helping students demonstrate these competencies and not be constrained by the traditional requirements formulated in terms of courses: one-year of organic chemistry or a semester of neuroscience, for example. In addition to giving educational institutions the freedom to construct innovative programs, the formulation in terms of competencies is much more explicit in explaining what students should know and be able to do. A year of organic chemistry, though there is a general consensus of what that means, still might cover a multitude of different topics—only a few of which might be relevant for future physicians.

The SFFP and MCAT are far from being pioneers in the use of competencies to express learning objectives. In engineering, the ABET accreditation program (ABET 2009) moved to a competency model in 2000. More recently, the report Vision and Change in Undergraduate Biology Education (Brewer and Smith 2011) articulates the objectives for undergraduate biology majors in terms of competencies. The US Medical Licensing Exam has moved to a competency model by asking examinees to use their science knowledge to reason about medical problems rather than simply regurgitating facts. In K–12 education, the recently released Framework for K–12 Science Education (National Research Council 2012) and the accompanying draft of the Next Generation Science Standards (http://www.nextgenscience.org/) explicitly link scientific content knowledge with science and engineering practices, which demonstrate the ability to use the content knowledge in a variety of ways.

A 2002 National Center for Educational Statistics report, Defining and Assessing Learning: Exploring Competency-Based Initiatives (Jones, Voorhees, and Paulson 2002), defines a competency as “a combination of skills, abilities, and knowledge needed
to perform a specific task.” In the broader context of undergraduate education, “Competency based initiatives, then, are those purposeful actions undertaken by postsecondary institutions directed at defining, teaching, and assessing competencies across their system.” (Page vii).

The report goes on to describe methods that help students become competent. “Competencies are the result of integrative learning experiences in which skills, abilities, and knowledge interact to form bundles that have currency in relation to the task for which they are assembled” (Jones, Voorhees, and Paulson 2002).

To show how a competency model informs the natural sciences content of the revised MCAT, we need to first describe the changes that AAMC is implementing. At a structural level, the revised MCAT will consist of four sections:

1. Biological and Biochemical Foundations of Living Systems
2. Chemical and Physical Foundations of Biological Systems
3. Psychological, Social, and Biological Foundations of Behavior

New to the revised MCAT is the section on the psychological, social, and biological foundations of behavior (see the Frazier and Twohig article in this issue). In short, this new material reflects the increasing recognition that in many cases the behavioral and social components of health and disease are just as important as the molecular and physiological components.

The Critical Analysis and Reasoning Skills section is a direct replacement of the current Verbal Reasoning section and will ask the students to read and answer questions about passages from the humanities and social and behavioral sciences. All the information needed to answer the questions will be provided in the passage.

The revised MCAT will have more biochemistry and cell and molecular biology than does the current exam. The biochemistry will be limited to that covered in a one-semester foundational course as recommended by the American Chemical Society’s guidelines for undergraduate chemistry programs (Committee on Professional Training 2008). The cell and molecular biology concepts will be at the level taught in many introductory biology courses across the country. These changes were made in recognition of the growing importance of knowledge of the biochemical and cell and molecular biology basis of health and disease in the practice of medicine.

The biological, chemical, and physical parts of the revised exam will be built around five foundational concepts, which play the role of the competencies laid out in the SFFP report. Those five concepts are:

1. Biomolecules have unique properties that determine how they contribute to the structure and function of cells and how they participate in the processes necessary to maintain life.
2. Highly organized assemblies of molecules, cells, and organs interact to carry out the functions of living organisms.
3. Complex systems of tissues and organs sense the internal and external environments of multicellular organisms and, through integrated functioning, maintain a stable internal environment within an ever-changing external environment.
4. Complex living organisms transport materials, sense their environment, process signals, and respond to changes using processes understood in terms of physical principles.
5. The principles that govern chemical interactions and reactions form the basis for a broader understanding of the molecular dynamics of living systems. (AAMC 2011, 10–11)

Each foundational concept is supported by a listing of appropriate content topics, which we will not describe here. (In the SFFP report there is an intermediate layer of learning objectives associated with each competency. The SFFP report consciously avoided listing specific, detailed content topics.) The list of “allowed” MCAT content topics was generated by having current MCAT science topics rated by medical school basic science faculty, residents, and medical students and correlating those topic rankings with what undergraduate faculty report is commonly taught. The details of the process and the complete list of content topics are available through the AAMC web site: https://www.aamc.org/initiatives/mr5/.

In addition to science content topics, the MCAT will test scientific inquiry and reasoning skills (SIRS):

- Knowledge of Scientific Concepts and Principles
- Scientific Reasoning and Evidence-Based Problem Solving
- Reasoning about the Design and Execution of Research
- Data-Based and Statistical Reasoning

Note that the quantitative skills focus on reasoning about data using statistics and other mathematical tools. These skills are just those that are taught—sometimes implicitly rather than explicitly—in the laboratory components of most introductory college and university science courses. Students will not be expected to have taken courses specifically in research methods.

These skills will not be tested in isolation. Students’ competencies in the natural sciences and quantitative reasoning will be tested by writing questions that ask students to apply one or more of the SIRS skills and their content knowledge to answer questions about passages that describe scientific problems in the context of living systems.

**IMPLICATIONS FOR UNDERGRADUATE EDUCATION**

How will undergraduate institutions help students who are interested in medical careers develop these competencies? As a
first approximation, undergraduate faculty need not do much more than make sure that students have experience using the scientific inquiry and reasoning skills described above to solve scientific problems. In addition, chemistry and physics faculty should give students practice in applying the concepts of chemistry and physics to situations that apply to the understanding of living systems. Education research has shown (Bransford, Brown et al. 1999) that students have difficulty applying what they have learned in contexts different from the context in which the material was first learned. Of course, this transfer of learning is something we want our students to master, so having them practice applying their knowledge and scientific reasoning skills in a wide variety of areas is a virtue in its own right.

As mentioned previously, the focus on competencies allows colleges and universities to think about creative curriculum innovations such as integrated science courses. SFFP undergraduate competencies, though focused on future physicians, are broadly applicable for all prehealth students and in fact, in the opinion of the authors should be part of the education of all science students.

IMPLICATIONS FOR MEDICAL EDUCATION

The move to competency-based education in the undergraduate learning environment is wholly aligned with current pedagogical approaches to undergraduate medical education and graduate medical education. Medical schools anticipate several advantages to an undergraduate science experience that is constructed and defined by competencies rather than by courses.

First, medical schools themselves have almost uniformly embraced competencies as a strategy for identifying and assessing the knowledge, skills, and attitudes needed to be a successful physician. Scientific advances that increase our understanding of disease and therapy are occurring at a rapidly accelerating rate. Medical schools design educational and assessment programs to ensure that their graduates have mastered the ability to apply scientific concepts to the evaluation and management of patients today as well as to sustain their competency in science-based care over careers that frequently span four or more decades of scientific discovery. They realize that their focus must be primarily on scientific competency: integration and application of scientific concepts and critical reasoning skills, rather than the recall of scientific facts. Undergraduate students whose mastery of scientific concepts is described using a competency framework will fit into the continuum of learning that currently defines undergraduate medical education and graduate medical education.

Second, many medical schools have moved from discipline-based courses as the teaching strategy for biomedical sciences to integrated courses including biomedical, social, and behavioral sciences along with clinical application. Competencies, designed to focus on the integration of the knowledge and on the attitudes and skills necessary to perform in a desired manner, play a major role in the design of these integrated courses and the assessment of students taking these courses. For example, courses such as the University of California–San Francisco's integrated Brain, Mind, and Behavior course will likely incorporate concepts from neurophysiology, neuroanatomy, neuropsycharmacology, neuroradiology, neurology, and psychiatry to help students develop competencies such as reading the scientific literature relevant to these fields as well as evaluating and managing patients with neurologic or psychiatric complaints. A competency-based framework will allow schools to define more precisely the background students must have to succeed in their unique integrated curriculum.

Third, competency-based undergraduate science education and competency-driven MCAT exams may help standardize the preparation of students matriculating into medical schools while also providing some flexibility in coursework. Current medical school entrance requirements focus on time in courses (i.e., one year of physics, one year of organic chemistry with a lab) and grades as the only evidence of adequate preparation for the medical school curriculum. Unfortunately, courses, even those using the same textbook, can vary substantially from institution to institution, leading students to believe that they have mastered the content needed to successfully navigate a given medical school's curriculum because they have taken a course with the right name. Additionally, concepts in foundational sciences needed to succeed as a health professional have expanded to include informatics and engineering (systems and biomedical), as well as social and behavioral sciences. If we continue to rely upon successful completion of an undergraduate course as the only acceptable evidence of adequate preparation for advanced study in medical school, we will quickly find our students unable to pursue anything other than medical school prerequisites during their undergraduate experience. This would constrain students' abilities to pursue more in-depth experiences in biomedical sciences or any experience in fields not required for medical school preparation. The result would be a generation of physicians who do not have the diversity of thought and experience desired in members of the medical school and professional community.

Fourth, medical schools will be better able to align student preparation with the curriculum that best supports their school's mission, vision, and values. Schools that aim to produce biomedical scientists may choose to require that their applicants demonstrate advanced competencies in core biomedical sciences so that they can focus their school's curricula on cutting-
The prehealth pyramid builds upon the traditional emphasis on the physical and biological sciences, recognizing the need for continuing updates. The behavioral and social sciences component can be viewed as essential content for the practice of the health professions. The behavioral and social sciences should incorporate an increasingly sophisticated biological understanding of human behavior and social interactions as applied to health problems.

The Scientific Inquiry and Reasoning Skills (SIRS) provide the glue that aims to hold these content components together. They include scientific and evidence-based thinking, study design and execution, and data-based and statistical reasoning.

The dotted lines are intended to imply an increasingly porous relationship between the traditional disciplines. The prehealth pyramid implies that health professions education should be built on a foundation of integrative sciences. Together these components of the prehealth pyramid are designed to produce a coherent whole that allows students to see the relationships between the disciplines.

The prehealth pyramid aims to assist health professions educators to build on a solid understanding including both the process and the content of the physical and biological sciences as well as behavioral and social sciences. Ideally this integrative approach will do more than prepare students for the new MCAT. It will help guide the transformation of undergraduate preparation for the health professions.

REFERENCES


The Scientific Foundations for Future Physicians report recognized that evidence-based medicine is central to medical education and the practice of medicine. The report states: “It is essential not only to read the medical and scientific literature of one’s discipline, but to examine it critically to achieve lifelong learning. These activities require knowledge and skills in critical analysis, statistical inference, and experimental design” (Association of American Medical Colleges and Howard Hughes Medical Institute 2009).

There is strong evidence that most medical students and residents are not equipped with the tools to critically read the evidence and apply it to solve clinical or research problems. For instance, investigators from Yale surveyed Connecticut internal medicine residents state-wide and found, in an investigation published in JAMA, that only about 40 percent were able to correctly answer key study design and statistical questions (Committee to Evaluate the USMLE 2008).

If students are to gain competence in the ability to understand study designs and analyze findings, these skills need to be introduced and reinforced through practical application as part of the undergraduate curriculum as well as medical school and residency. The National Board of Medical Examiners has recognized this need and is piloting questions that utilize abstracts of articles and simulated journal advertisements to test understanding of study design and statistical questions (Committee to Evaluate the USMLE 2008).

Scientific Thinking and Integrative Reasoning Skills (STIRS): Essential Outcomes for Medical Education and for Liberal Education

Richard K. Riegelman, professor and founding dean, School of Public Health and Health Services, The George Washington University

Kevin Hovland, senior director for global learning and curricular change, AAC&U

The SIRS framework comprises the following skills:

1. **Knowledge of Scientific Concepts and Principles**
   Recognizing and using fundamental scientific concepts and principles, retrieving information, identifying the relationships between closely-related concepts, and using mathematical equations

2. **Scientific Reasoning and Evidence-Based Problem Solving**
   Using scientific principles, models, and theories to describe, explain, and make predictions about natural phenomena; working with theories and models to solve problems; and evaluating arguments about causes and consequences

3. **Reasoning about the Design and Execution of Research**
   Evaluating features of research studies to determine if conclusions of the research are warranted, and making predictions based on the features of a research design

4. **Data-Based and Statistical Reasoning**
   Using quantitative and qualitative data to describe and explain phenomena in the natural world; explain the relationships between variables; test hypotheses; solve problems; interpret, draw conclusions, and make comparisons; interpret and make predictions from qualitative or quantitative data presented in tables, figures, and graphs

(Association of American Medical Colleges 2011):
The MR5 identified and AAMC has endorsed a more detailed list of capacities that students should gain in order to demonstrate each of the SIRS skills as part of the new MCAT exam. See Figure 1.

**CROSS LINKING SIRS WITH CONTENT EXAMS**

SIRS will not form the basis for a separate component of the MCAT—rather its four Skills will be cross linked with the Foundational Concepts and content categories from each of the three content areas of the new MCAT exam. The content areas are

- Biological and Biochemical Foundations of Living Systems
- Chemical and Physical Foundations of Biological Systems
- Psychological, Social and Biological Foundations of Behavior

Each of these three sections will be organized around three dimensions:

- Foundational Concepts—the “big ideas” in the sciences that provide the foundation for learning in medical school;
- Content Categories—the topics and subtopics that are needed to understand the foundational concepts; and
- Scientific Inquiry and Reasoning Skills—the inquiry and reasoning skills that are required to solve scientific problems.

For instance, a question about laboratory studies of radiation exposure might require a student to examine the chemical and physical impacts of radiation on living systems and draw conclusions based on laboratory as well as population data. Such questions would link SIRS Skill 2 (Scientific Reasoning and Evidence-based Problem Solving) and SIRS Skill 4 (Data-based and Statistical Reasoning), with Chemical and Physical Foundations Concept 4 (Complex living organisms transport materials, sense their environment, process signals, and respond to changes using processes understood in terms of physical principles.)

**FIGURE 1. CAPACITIES THAT STUDENTS SHOULD GAIN TO DEMONSTRATE SIRS SKILLS**

<table>
<thead>
<tr>
<th>Skill 1—Knowledge of scientific concepts and principles: Students should be able to</th>
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<tbody>
<tr>
<td>state or recognize correct science concepts and principles;</td>
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<tr>
<td>recognize relationships among closely-related scientific concepts and principles;</td>
</tr>
<tr>
<td>recognize relationships among different representations of concepts and principles;</td>
</tr>
<tr>
<td>use mathematical representations of concepts and principles; and</td>
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<tr>
<td>recognize graphical or schematic representations of concepts and principles.</td>
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<tr>
<th>Skill 2—Scientific reasoning and evidence-based problem solving: Students should be able to</th>
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<tr>
<td>work with scientific models and theories to solve problems;</td>
</tr>
<tr>
<td>make claims and propose research questions or hypotheses based on scientific theories and models;</td>
</tr>
<tr>
<td>identify assumptions and logical inconsistencies in arguments to evaluate a conclusion;</td>
</tr>
<tr>
<td>propose and/or evaluate alternative explanations or predictions;</td>
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<tr>
<td>work with the stated conclusions from a research study to solve problems;</td>
</tr>
<tr>
<td>problems within a given context; and</td>
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<tr>
<td>use and evaluate proposed solutions.</td>
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<tr>
<th>Skill 3—Reasoning about design and execution of research: Students should be able to</th>
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<tr>
<td>identify foundational aspects of research design (e.g., experimental vs. nonexperimental design, independent and dependent variables);</td>
</tr>
<tr>
<td>identify the appropriate research designs needed to address specific research questions or hypotheses;</td>
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<tr>
<td>critique different aspects of a research design (e.g., identify sources of potential bias, confounds, adequacy of sample);</td>
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<tr>
<td>evaluate research designs to determine if conclusions based on the research study are appropriate;</td>
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<tr>
<td>recognize ethical issues inherent in research investigations; and</td>
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<tr>
<td>make predictions about expected results based on the features of a research design</td>
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<tr>
<th>Skill 4—Data-based and statistical reasoning: Students should be able to</th>
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<tr>
<td>use data to describe phenomena in the natural world and/or to describe results of a research study;</td>
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<tr>
<td>use descriptive statistics to summarize data (e.g., mean, median, and standard deviation) and relate it to the population (e.g., standard error);</td>
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<tr>
<td>interpret data or patterns in data to draw conclusions or evaluate the conclusions made at the end of a research study (e.g., notice whether conclusions logically follow based on the data presented);</td>
</tr>
<tr>
<td>interpret data, or patterns in data, to make predictions;</td>
</tr>
<tr>
<td>use statistics to answer research questions and evaluate the strength of the evidence provided in support of given hypotheses; and</td>
</tr>
<tr>
<td>interpret data patterns presented in tables, figures, and graphs (e.g., histograms, scatterplots) to interpret results, make comparisons, and draw conclusions.</td>
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The AAMC MCAT 2015 Preview emphasizes that SIRS is still in the development phase and cannot yet be formulated as a comprehensive list of performance expectations. Consequently, these lists are illustrative, not exhaustive. (Association of American Medical Colleges 2011).
they participate in the processes necessary to maintain life.) and principles of neurological development using Biological and Biochemical Foundational Concept 2 (highly organized assemblies of molecules, cells, and organs interact to carry out the functions of living organisms). It might also incorporate Psychological, Sociological, and Biological Foundations of Behavior Foundational Concept 9 (social and cultural differences influence well-being) and Psychological, Sociological, and Biological Foundations of Behavior Foundational Concept 10 (social stratification affects access to resources and well-being) to ask students to examine the advantages and disadvantages of options for individual folic acid supplementation of women of childbearing age as well as supplementation of the food supply. SIRS Skill 3 (Reasoning About the Design and Execution of Research), as well as SIRS Skill 4 (Data-Based and Statistical Reasoning), can be cross-linked to issues of neural-tube defects and folic acid by asking students to evaluate the randomized controlled trials as well as observational studies used to demonstrate the effectiveness and safety of increased folic acid intake in reducing neural tube defects.

In examples like those above, SIRS should be viewed as the glue binding the diverse components of the MCAT exam and the competencies needed to prepare for medical school. These skills form a solid foundation on which to build a comprehensive sequenced curriculum in evidence-based medicine in medical school and beyond.

**SCIENTIFIC THINKING AND INTEGRATIVE REASONING SKILLS (STIRS): A NEW PROJECT AT AAC&U**

Integrating Scientific Inquiry and Research Skills into the MCAT and other preprofessional examinations is both a challenge and an opportunity because higher education remains without a comprehensive approach to teaching such basic skills, including research design and analysis, as part of an undergraduate education.

This issue of *Peer Review* marks the launch of a new project at AAC&U that incorporates these essential skills into a broader effort to encourage evidence-based thinking as a core outcome of general education. The Scientific Thinking and Integrative Reasoning Skills (STIRS) project aims to help reinvigorate the science and social science components of general education for all students, not just those preparing for the health professions. The STIRS project builds on existing AAC&U efforts, especially Liberal Education and America’s Promise (LEAP), to emphasize the importance of integrating evidence-based thinking into a wide range of disciplines including, but not limited to, the sciences and social sciences.

The STIRS project will expand the basic framework developed as part of the MRS process to include analytical and logical reasoning and decision-making skills such as those used currently in the LSATs, as well as other standardized examinations, such as the GMAT and GREs. AAC&U will incorporate the STIRS outcomes into its ongoing efforts to help campuses create more intentional pathways between learning goals, curricular designs, and demonstrated student learning. In particular, AAC&U will use STIRS to highlight the integrative power of general education and to help students connect the learning that occurs in general education courses with their majors and with applications to real-world problems and projects.

STIRS will build on significant efforts at AAC&U and across the academy to define and advocate a set of Essential Learning Outcomes that inform curricular designs, pedagogical approaches, and resource allocation across undergraduate education. STIRS will focus important attention on efforts to ensure that all students can

- Use scientific reasoning to gather and evaluate evidence
- Understand how scientific and social science studies are designed and executed
- Understand the implications of design choices
- Use statistical reasoning to evaluate data and use data to communicate effectively
- Make decisions based on analysis of evidence, logic, and ethics

The draft STIRS curricular framework includes the following skills:

- Scientific Reasoning and Evidence-Based Decision Making
- Study Design, Execution, and Implications
- Data-Based and Statistical Thinking
- Analytical and Logical Reasoning
- Evidence-Based Decision Making

The STIRS framework is further illustrated through the development of “Enduring Understandings” designed to identify the key components that students need to take away from the curriculum, incorporate into their majors, and utilize as part of their continuing education for many years to come. Excerpts from a draft version of “Enduring Understandings” for each of the components of the framework are being developed and are illustrated below in figure 2.

STIRS project participants will

- Develop and sustain a community of educators committed to teaching STIRS skills to all students as part of an integrative approach to general education.
- Encourage, review, and reward the development of curricular modules that assist in teaching and assessing components of the STIRS framework through peer review recognition and the designation of “STIRS Scholars”
- Utilize existing AAC&U VALUE Rubrics as an instrument to assess institutional achievement of the STIRS framework.

For more information, or to get involved in the STIRS project, contact Kevin Hovland at hovland@aacu.org.
**CONCLUSIONS**

The changes in the MCAT set the stage for broader reform in general education, as well as in science and social science majors, that takes an integrative approach to evidence-based thinking. These skills have long been valued as part of liberal education but have not yet been integrated as core skills for all undergraduates. The AAC&U STIRS project aims to take the next steps by developing a curriculum framework encouraging a wide range of faculty to submit curricular materials that may be used to implement the framework. Peer review of the curricular materials and recognition of excellence by designation of “STIRS Scholars” will move scientific thinking and integrative reasoning skills to the center of conversations about the essential learning outcomes associated with general education and liberal learning. Consequently, higher education will be better able to equip students with key skills they need to understand—and perhaps begin to solve—complex, real-world problems.

**NOTE**

To receive a complete set of draft enduring understandings and provide feedback, please contact Richard Riegelman at riegel@gwu.edu

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**FIGURE 2. ENDURING UNDERSTANDINGS OF THE STIRS PROJECT**

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**THE FOLLOWING ARE EXAMPLES OF THE TYPES OF ENDURING UNDERSTANDING THAT ARE BEING DEVELOPED FOR EACH OF THE COMPONENTS OF THE AAC&U STIRS PROJECT:**

### Scientific Reasoning and Evidence-Based Problem Solving

Scientific reasoning may be divided into reductionist science and integrative science or systems thinking. Social and behavioral sciences as well as the biological and physical sciences may be structured as either reductionist or integrative sciences with integrative sciences often building on reductionist science. Reductionist science aims to create study and control groups that are as similar as possible except for the factor under investigation. Reductionist science is grounded in disciplinary approaches often determined by the levels of organization of the material and social world. Subatomic and atomic physics, inorganic and organic chemistry, zoology and botany, and population sciences such as epidemiology all may take a reductionist approach focusing on one relationship or association at a time.

### Study Design, Execution, and Implications

Study designs may be divided into experimental and observational. In experimental designs the investigator intervenes to change the conditions and compare the outcomes in the intervention or study group(s) compared to outcomes in the control group(s) without the intervention. In observational studies the investigator observes the occurrence of events without intervening. The investigator may begin by identifying an independent variable and observing the subsequent occurrence or lack of occurrence of the outcome measured by the dependent variable. Alternatively, the investigator may first identify the occurrence or lack of occurrence of the outcome measured by the dependent variable and look back in time to identify the occurrence or absence of occurrence of the factor measured by the dependent variable. Observational studies are potentially capable of establishing the first two criteria of contributory cause or efficacy: (a) that there is an association between the independent and the dependent variable at the individual level and (b) that the “cause” precedes the “effect.” Experimental interventions are often required to definitively establish the third criterion, namely that altering the “cause” alters the “effect.”

### Data-Based and Statistical Reasoning

Statistical analysis aims to draw conclusions about large groups or populations based on investigations of smaller groups called samples. Samples are designed to be representative of the larger population of interest. The type of statistical analysis that is conducted depends on the goals of the analysis. Potential goals of statistical analysis include estimation of the magnitude or strength of the relationship, statistical significance or inference, adjustment or taking into account potential confounding variables, and prediction or prognostication. The specific statistical methods used also depends on the type of data used to measure the independent and dependent variables, the distribution of the data, and the frequency of measurement of the dependent or outcome variable.

### Analytical and Logical Reasoning and Evidence-Based Decision Making

Analytical reasoning requires understanding of the structure of relationships and drawing logical conclusions based on that structure. Logical reasoning includes the analysis and critical evaluation of statements or arguments and the drawing of well supported conclusions. Reasoning by analogy, determining how additional evidence affects an argument, applying principles or rules, and identifying flaws in arguments are all key skills in critical analysis.

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Excerpted from the draft of enduring understandings, developed for components of the AAC&U STIRS project.

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**REFERENCES**

The New Social and Behavioral MCAT Requirements: Inspired Innovation, Missed Opportunity, or Both?

The influence of the modern medical school on the liberal arts education in this country over the last decade has been baleful and malign, nothing less.

Lewis Thomas (1978)

The implementation of the new Medical College Admissions Test (MCAT) in 2015 will cap off over a century of discussion on the efficacy of various premedical curricula (Chambers et al. 2011) and provides an opportunity for the influence of premedical programs on liberal education to become not merely benign but highly positive. The Final Recommendations of the Association of American Medical College’s MR5 Committee (AAMC 2011a) call for the new MCAT to include a social and behavioral science component equal in scope to the biological and physical sciences portions of the exam. The test developers indicate that there will be approximately sixty-five questions in this section, taking approximately ninety-five minutes to complete. The committee proposes that 60 percent of this section be based on psychology, 30 percent on sociology, and 10 percent on biology, although they note that these percentages might change. There are twelve proposed foundational areas in the test that address the major psychosocial themes (see fig. 1). The proposed undergraduate coursework for these sections includes one course each in psychology and sociology, and two biology courses. These will be introductory courses, as more advanced courses in these fields usually require completion of the introductory courses as prerequisites.

We think the greater emphasis on psychosocial issues is very important because medically or biologically based disorders do not occur in isolation, and their prevention and treatment involve human activities, both on the part of the patient and the health professional. This concept is often referred to as the “biopsychosocial model” (Taylor 2012). It is imperative to emphasize an understanding and appreciation of the reciprocal relationship between environmental/psychological variables and issues related to health on the MCAT. Overall, a greater understanding of these variables will result in greater advances in medical science and greater proficiency in medical practice, including improved success in preventing, diagnosing, and treating disease and injury. Such understanding also is necessary to enable patients to comply with health maintenance and treatment plans. The dramatic demographic changes occurring across America also provide ample impetus for future physicians to increase their understanding of “the ways that individuals perceive, think about, and react to the world” (AAMC 2011b) in order to practice their craft successfully.

CONCERNS

Still some issues remain unresolved. The most pertinent is whether the coursework that is suggested to prepare the test takers for this section of the MCAT is really designed and taught in a way that will accomplish proficiency. One concern is whether current course curricula and materials will prepare students to answer these types of questions; a second is whether the material in such courses is presented in a way that facilitates the type of understanding that is required of examinees taking the MCAT. To understand this fully, one first needs to look at the type of knowledge that will be tested.

Sample questions provided by AAMC (2011b) to represent the types of questions that would occur in the psychological, social,
and biological foundations of behavior science section of the test have a uniform style. First, they provide a brief synopsis of a research study along with a figure depicting the results. Subsequently, the test asks five questions pertaining to the study. A portion of the questions have to do with the application of existing knowledge to the questions asked. For example, a student might be asked which brain region is associated with the issue described in the study. In this case, the answer may have been taught in the neurology section of an introductory psychology course, and hopefully will be recalled during the test. The remainder of the questions—and it appears to be greater than 50 percent of them—involve the application of the scientific method to the interpretation of findings from the study. Content and definitional knowledge appear to be relevant to answer these questions too, but it seems that the core concepts focus on evaluating the study’s design and making sense of the findings.

A review of undergraduate syllabi in introductory psychology courses revealed that much of the proposed MCAT content may be covered when professors closely follow a textbook (Bates 2004). Just about every content area listed in figure 1, is included in introductory texts but the coverage typically is cursory at best. For example, conceptualization and diagnosis of psychological disorders is covered in a few pages at the beginning of one chapter, with disorder specific information limited to perhaps one paragraph each. The coverage of disorders typically provides only a definition of each disorder. There is insufficient space allocated to address issues related to etiology, maintenance, or treatment.

The function of an introductory course is to provide an overview of the major areas in a field. There simply is not time to provide deeper coverage of many areas. Strong instructors and increased study by the student can certainly increase the functional knowledge gained in introductory courses, but that may or may not achieve the desired end. A study of undergraduate psychology curricula by the American Psychological Association (Halpern 2010) concluded that: “Although many institutions already standardize the textbooks adopted for the introductory course, few standardize the content of what is taught. … Given that the introductory course serves as a foundation for the major and is sometimes the only exposure to the field for nonmajors, widely variable content and delivery do the field and the student a disservice.” Thus, it seems unwise to assume that students who take only an introductory psychology course will be well prepared for the new social and behavioral section of the MCAT. We suspect that the same variability exists among introductory sociology courses.

Another option is to increase the number of courses suggested in these areas. This is a distinct possibility because there are higher level courses in each of the areas to be tested in the new MCAT. For example, there are courses on abnormal psychology that cover etiology, diagnosis, assessment, and treatment of psychological disorders. Such a course is likely taught at all undergraduate institutions that offer psychology as a major. Realistically, however, requiring additional courses is not feasible for a variety of reasons, and the MR5 Committee wisely advised against increasing the number of courses required for premedical students. Other ways to make the material covered in these courses more applicable for careers in medicine need to be considered. Perhaps one approach would be to reconstitute the manner in which these topics are covered in introductory psychology and sociology courses. This particular approach, which is also the one recommended by Halpern (2010), might result in an overall improvement in undergraduate general education.

**Understanding the Philosophy of Science and the Scientific Method**

As mentioned previously, it appears that approximately 50 percent of the content of the test questions on the new section of the MCAT have more to do with an understanding of what valid implications might be made from the study presented, rather than simply recalling previously learned material. Thus, the central issue appears to be one of understanding the philosophy of science and the scientific method. While philosophy of science and research methods may be covered in other undergraduate...
coursework, their application to these finer areas of psychology receive only cursory coverage in many introductory psychology courses (Bates 2004). Again, a quick review of introductory texts in these areas shows that about half of one chapter is devoted to research methods, experimenter biases, and heuristic errors. Unfortunately, either because they are so elementary, or this is not seen as a main focus for such courses, there is very little integration of teaching the application of the scientific method or the philosophy of science in many introductory courses. Specific instructors can choose to include these topics or not. Therefore, we suggest that either social psychology research methods courses are also taken as part of the premedical curriculum, or greater emphasis be given to philosophy of science and research methods throughout introductory courses. This would include teaching and discussions related to types of epistemology and other issues of knowledge and understanding. The scientific method holds special value as a form of epistemology, and its applications and ramifications should be understood. One option is to increase time spent on philosophy of science and the scientific method earlier in introductory courses, and then present all following material in this context.

For example, a typical introductory psychology course would provide information on the history and background of the field of psychology, including the varying views of where knowledge comes from. Consequential sections would focus on research methods, personal biases, and heuristic errors. All following chapters—including ones on neurosciences, sensation and perception, learning, motivation, human development, and so on—would occur with an underlying discussion of why professionals view these things in such a particular way. The course may cover less factual content but more process, as well as the reasoning and evidence upon which scientists believe something to be so.

THE NEW MCAT REQUIREMENTS AND LIBERAL EDUCATION

While the MRS is going in the right direction with regard to the content areas they suggest be learned by students taking the MCAT, their recommendation (AAMC 2011b) that the proposed exam for the social and behavioral sciences will “target concepts taught at most colleges and universities in one-semester introductory psychology and one-semester introductory sociology courses” is not the optimal strategy. Introductory courses in psychology and sociology provide only an overview of these topics rather than their actual application as they will be covered in the new MCAT. It is unlikely that existing introductory psychology and sociology courses at most universities include the important information that AAMC suggests premed students study prior to taking the social and behavioral section of the new MCAT (table 1). Thus, some universities might respond by developing new introductory sociology and psychology courses specifically designed for premed students. This would result in a missed opportunity, not only for premed students but also for other students across the university and for faculty as well.

Thomas (1978) and others (e.g., Gunderman and Kanter 2008) have made it clear that (1) the premedical curriculum exerts enormous influence on general education requirements at many universities and (2) there is much to be said for not sequestering premedical students from their peers in other disciplines during the undergraduate years. Instead of bemoaning or resenting the effects that premedical programs have on general and liberal education, they should be used to the advantage of all. Indeed, many, if not most, of the recommended topics for the social and behavioral section of the new MCAT are equally valuable to any undergraduate student and are suggested by the American Psychological Association for undergraduate education in psychology (American Psychological Association 2007). Specifically, in an age where patients are “consumers of health care,” knowing ways in which to judge treatment options or interpret advertising for health care options would help individuals seek out medical choices that are more likely to be helpful. Similarly, there is utility in having wise consumers who have methods to judge when treatment is not working, and the competence to look for alternative options and evaluate their utility.

This might also aid in the prevention and implementation of medical treatment. If patients understand their own motivations to follow or not follow treatment plans and health maintenance regimes, it is likely that their compliance will improve. It can be argued that bankers, real estate agents, theater professionals, artists, English teachers, political scientists, and historians will be more successful if they, too, understand the biological, psychological, and social basis of human behavior.

Furthermore, all of our undergraduates will be exposed to the same changing demographics and cultural shifts in their professional lives that future physicians will encounter in theirs. All of our students will be faced with an increased diversity of beliefs, communities of mixed ethnicity, cultural complexity, and economically disparate populace. Similarly, to be culturally competent within a community, one needs to be able to see others’ points of view, have empathy for the choices they make, and have the character to treat others with civility (Fluker 2011). This involves understanding why individuals of different backgrounds make the choices they do, and then adjusting the context and our actions to incorporate their worldviews.

Rather than relying on individual colleges and universities to come up with their own tailor-made programs for premed students (Chambers et al. 2011),
or assuming that existing introductory coursework in sociology and psychology will somehow prepare students for the new MCATs, the AAMC could use its enormous influence to help us change the very nature of general education. By joining with organizations such as AAC&U, AAMC could help bring about a fundamental change in liberal arts education in the social and psychological sciences—to the benefit of all undergraduates. The MR5 recommendations “require examinees to use knowledge of social and behavioral sciences concepts to demonstrate skill in scientific inquiry and reasoning, research methods, and statistics.” What student in any discipline could fail to benefit from such a requirement?

We also believe that most students across the university campus could benefit from exposure to much of the other content necessary to prepare premedical students for taking the new MCAT. As pointed out by the authors of Rising Above the Gathering Storm Revisited (National Academy of Sciences 2010), “[T]he need to strengthen science and math education in the nation’s public schools is not simply to produce more graduates possessing the qualifications needed to pursue careers in science and engineering. The spectrum of jobs that is available to high school as well as college graduates is increasingly demanding at least rudimentary skills in these fields.” Much of the content in the natural sciences sections of the proposed new MCAT also would benefit any denizen of an advanced technological society. The Critical Analysis and Reasoning Skills (CARS) section, in particular, tests skills that are necessary for anyone who seeks to be an informed maker of choices in a democratic society. Again, what individual would not benefit from the CARS skills specified by the AAMC (2011b, 133):

- Foundations of comprehension
- Understanding the basic components of the text
- Inferring meaning from rhetorical devices, word choice, and text structure
- Reasoning within the text
- Integrating different components of the text to increase comprehension
- Reasoning beyond the text
- Applying or extrapolating ideas from the passage to new contexts
- Assessing the impact of introducing new factors, information, or conditions to ideas from the passage

Indeed, in these times of ideological predominance, the ability to become adept at “evidence-based problem solving” (Riegelman 2012) seems essential not just for health care professionals but for all citizens. As universities prepare premedical students and their fellow students throughout the campus for their future roles as professionals and workers, we would do well to remember the following warning recently provided by the National Task Force on Civic Learning and Democratic Engagement in A Crucible Moment (2012):

Higher education in a robust, diverse, and democratic country needs to cultivate in each of its graduates an open and curious mind, critical acumen, public voice, ethical and moral judgment, and the commitment to act collectively in public to achieve shared purposes. In stark contrast, higher education in a restrictive, undemocratic country needs only to cultivate obedient and productive workers.

We agree that it is absolutely imperative for premed students to understand “the ways in which psychological, social, and biological factors influence our perceptions and reactions to the world, behavior and behavior change, what we think about ourselves and others, cultural and social differences that influence well-being, and the relationships between social stratification, access to resources, and well-being” (AAMC 2011b, 91). But it is equally imperative for all students to share in that same level of understanding if we are to continue as a strong democratic republic (Haring-Smith 2012).

REFERENCES


The new emphases in the MCAT exam will have ripple effects on curriculum, pedagogy, and student success. To ensure the effects are positive, faculty who work with undergraduates will want to reflect not only on how best to adapt courses, but also on how to advise students on entrance to medical school. Perhaps the biggest challenge will be how to ensure that a diverse population of students will discover and strengthen their aspirations for a medical career, and not fear that one standardized exam will be a barrier.

For some time, recognizing the specific challenges faced by minority and first-generation students, precollege programs such as Project Success at Boston’s West Roxbury High School and health science magnet schools in Dallas and Santa Monica have been identifying students who have the interest and potential for a medical career. Too often, without role models and appropriate counseling, these secondary school students do not take the mathematics and science courses that will be important for later success in college premedical requirements. Yet course work alone is not enough to build the confidence and competencies necessary for the level of challenge these students will encounter in college and medical school. Consequently, many of these specialty schools and inner-city programs use engaging pedagogical approaches such as inquiry learning, project-based work, and group collaboration to show students that they can take risks, learn through trial and error, and master increasingly complex material.

Similar initiatives—complemented by faculty and peer mentoring, internship opportunities, and research collaboration—are underway at the college level, aimed primarily at increasing both the number and diversity of students majoring in science, mathematics, computer science, and engineering. Comprehensive services including counseling, tutoring, cocurricular experiences, and career planning provide essential support so that more students will persist and meet demanding standards. Extending this type of outreach and support to students who may not have considered medicine before entering college, as well as to those who are taking the premed courses but majoring in other fields such as anthropology, international relations, and government, could increase the diversity of applicants to medical school. Students’ success, both on the new MCAT and in medical school, depends on a well-developed capacity to integrate all aspects of their education and apply their knowledge and skills to new problems and in varied contexts. Designing opportunities for this integrative work requires faculty leadership.

MODELS FOR PREPARING STUDENTS FOR THE NEW MCAT

The articles in this issue of Peer Review note several ways that curricula might change to prepare students for the new Social and Behavioral Science component of the MCAT, including (1) adding courses in sociology, psychology, and statistics to the current recommended course work; (2) changing the format of introductory courses in both the sciences and the social and behavioral sciences to be more interdisciplinary and problem based, and (3) creating courses specifically designed for premedical students, either in the major or to meet general education requirements. Using several of the criteria for success on the new MCAT—for example, critical thinking; interpreting data; analyzing issues using methods and concepts from several fields; and understanding the interaction of physical, psychological, and behavioral aspects of health—suggests that how something is taught is as important as what is taught. Any of these curricular structures can allow students to achieve the learning outcomes, if content, competencies, and experiences are aligned. Even then, each model may have a different effect in encouraging access and preparing students for medical school.

Option 1, mandatory requirements, is the easiest to implement and requires little change by the faculty or the institution, but leaves the responsibility for integrating the learning to the student. Consequently, this option does not ensure that a student...
at “Random University” will be as encouraged or well-prepared as a student at “Elite University,” who may have the benefit of smaller classes, better premed advising, and research opportunities. The drawback of merely adding requirements is that a given institution may choose not to modify courses to accommodate changes in premed and MCAT preparation in favor of preserving existing requirements for traditional biochemistry, psychology, and physics majors, for example, as these introductory courses serve students seeking entrance to doctoral degree programs and non-medical careers.

Option 2 emphasizes new curricular designs and pedagogies developed by faculty from different disciplines working intensively together to rethink the concepts and relationships of both traditional courses such as biology and newer fields such as neuroscience. Despite over a decade of leadership and support from organizations such as Project Kaleidoscope and the National Science Foundation, advances in integrative science education have been slow and not widespread. Thus, the new MCAT requirements may increase interest in reworking courses to emphasize interdisciplinary scientific reasoning yet not be sufficient to affect large numbers of students. Even with innovative curricular work, the impact on increasing underrepresented students’ preparation for medical school may still be limited unless recruitment and retention are a conscious intention of faculty.

Option 3 could include topics courses in “Health Economics” and “Medical Anthropology” for majors or general education courses, such as “Global Health,” in addition to the introductory courses in the sciences that typically meet general education requirements. This option does not require significant institutional change as the courses can fit into current curricular structures and need not be restricted to declared premed students. First-year seminars (FYS) are a natural home for these types of courses as they have limited enrollment and are often designed to be interdisciplinary and focus on relevant societal issues as well as foundation skills in writing and research. With inviting titles such as “From Atomic Bombs to Cancer Treatments” (UNC Chapel Hill) and “Outbreak! The Intersection of Plagues and Epidemics with Human Culture and History” (Wheaton College), individual faculty and students can come together around topics of mutual interest and explore how concepts and skills can be applied beyond the classroom. If advising is linked to the small enrollment seminar, faculty have an opportunity to identify other students who could be successful in premed courses with the right support.

Many campuses use service learning to increase students’ understanding of the community and diversity and provide context for career aspirations. For example, students in a FYS focusing on community health designed a research project on access to food and recreation facilities in a low-income neighborhood and then conducted a community survey. The next semester the data was given to majors in an upper-level political science course to analyze and prepare a policy report to the city council and health department. Both groups of students attended the public oral presentation and the ensuing discussion gave gravity and meaning to their work.

For the first-year students, the experience could have piqued the interest of some who had not previously considered a medical career as there was a low barrier to involvement in research on a real health problem. For the majors, whether premed or not, the project had value because it enabled them to complete a research project in one semester and required many of the competencies emphasized in the new MCAT, including evaluating research design and drawing inferences from data. The simplicity of this curricular option, two faculty taking initiative and working together to show students how to apply their knowledge and inquiry skills to practical problems, is appealing but would still require significant faculty leadership to scale it up and create enough courses to meet the needs of students across various majors. It may be that the premedical advisors, complemented by colleagues from other disciplines, are well positioned to provide such leadership for both curricular transformation and initiatives that reach out to students who do not immediately identify themselves as premed.
REWORKING PEDAGOGY TO STRENGTHEN INTEGRATIVE LEARNING

At the same time that faculty adapt the content of the curriculum to prepare students for the new MCAT, they will also need to rework their pedagogy to strengthen opportunities for students to develop the advanced intellectual capacities needed not just for the exam but also for medical school. Lecturing may once have been an efficient way to transfer information but it is not effective in helping students learn to use their knowledge and skills to create new knowledge, nor is it the format for learning favored by medical schools today. As faculty have learned more about how the brain works and how individuals synthesize their learning and transfer it to new experiences, many have changed classroom practices to embrace different learning styles, create more collaborative environments, encourage students to take different perspectives on issues, and demonstrate that mistakes are moments of learning. Faculty development programs are inspiring and guiding this shift from teaching to learning.

Structures and relationships that guide students to practice communication and quantitative skills in many courses, integrate concepts and methods across disciplines, and connect course and curricular experiences to the community and careers can help students be more intentional and meet the level of learning required by the new MCAT and medical school. Through national projects and institutes, AAC&U is making visible the varieties of this applied and integrative work on campuses and giving special attention to the evidence that demonstrates that threading skills, practical experience, reflection, and collaboration intentionally throughout the academic experience increases students’ intellectual, social, and personal capacities. The evidence that high-impact practices (HIPs)—such as group projects, internships, international experience, and undergraduate research—deepen learning for all students is persuasive. Of particular relevance, however, are studies showing that HIP experiences have the greatest benefit for minority students, as measured by grade point average and degree completion (Kuh 2008).

THE ROLE OF INTEGRATIVE LEARNING IN FROM COLLEGE TO MEDICAL PRACTICE

Clearly, entrance to and success in medical school is not guaranteed by a high score on the MCAT exam or an A in organic chemistry. Medical schools also seek students who are well-rounded, resilient, confident, and compassionate. Of particular importance is attracting students who will practice in underserved areas as well as those with cultural competence essential to serving the changing demography of the United States. Thus, there is increasing interest in admitting both students from underrepresented populations and majority culture students with the capacities to bring sensitivity and equity to medical care. The current work by faculty on many campuses to integrate service learning, community projects, and global perspectives into the curriculum provides essential opportunities for all students to develop their appreciation of others and become more comfortable with their own identity. Looking to the future, it is not unlikely that fluency in two or more languages will be a requirement for medical school.

Leaving aside concerns about whether a standardized test is the best predictor of success in medical school, the emphasis on integrative learning and outcomes as preparation for the MCAT reflects changing views on high-quality education and is consistent with the expected continuum of learning for medical practitioners. As colleges and universities make changes in premedical education, so too are medical schools changing their curricula to include more problem-based learning, earlier interaction with patients, and integration of community and global perspectives. Graduate medical education through internships and residency is primarily experiential, closely mentored, and competency based, with emphasis on interpersonal and communication skills, professionalism, systems-based practice, and practice-based learning and improvement equal in importance to medical knowledge and patient care.

Once in medical practice, physicians are now expected to maintain their skills and knowledge base through continuing education courses that require not just completion but a demonstration of competencies. This formal work is complemented by a self-directed “performance in practice” element utilizing periodic chart review in comparison to adopted professional practice parameters, direct feedback from peers and patients without necessarily the cover of anonymity, and an overall review of one’s practice as the basis for creating a plan for ongoing improvement. Faculty who want to reach more premedical students might adapt some of these elements that focus on achieving competencies rather than using courses, credits, or time to degree as measures of learning. Finding innovative ways to promote and extend students’ intellectual and personal development, such as through mentoring and feedback, peer review of their work, self-assessment, and intentional academic planning focused on career goals would serve all students.

REFERENCE

Implications of the MCAT Changes for Other Health Professions

Richard W. Valachovic, executive director, American Dental Education Association

Medical education has traditionally assumed a major leadership role in health professions education, and there is no doubt that innovations in medical education have had substantial influence on other units of the campus, especially in the academic health center. The environment in health professions education and healthcare is changing dramatically and rapidly, however, in ways that would have been unimaginable even a decade ago. Medicine still retains its substantial influence, but these changes provide an opportunity to develop a healthcare workforce that will provide for care that is delivered by a team of healthcare professionals working at the full scope of their education, training, and licenses. The new Medical College Admission Test (MCAT) will force changes in the preparation and expectation of students applying to medical school, but the new test will also have a collateral impact on students applying to other health professions as well. Through this article, I hope to provide a perspective on the implications that the new MCAT will have on other health professions.

THE NEW HEALTHCARE ENVIRONMENT: A SENSE OF URGENCY

The recent political focus on the Patient Protection and Affordable Care Act of 2010 (PPACA) has overshadowed many of the changes that are occurring in healthcare that are actually independent of the implementation of the new law. There is substantial healthcare reform already underway. The market is becoming more dominated by large healthcare systems such as United Healthcare and Kaiser Permanente, which are able to control the roles that healthcare providers play in these corporations. The number of physicians employed by these systems has increased significantly in recent years. Now there is a focus on collaborative practice that is being delivered more frequently in community-based settings. A number of recent reports, such as the IOM Future of Nursing Report (Institute of Medicine 2011) and the Lancet Commission Report (Frenk et al. 2010) on transforming health professionals’ education, highlight the compelling need for more interprofessional approaches to interprofessional education and practice. There is a recognized need for health providers to be lifelong learners and critical thinkers who can address the needs of patients with an intellectual curiosity over a career and not by rote memory of facts and practices that were contemporary at the time of their entry into practice. The future of collaborative healthcare practice will require that all of the members of the team have the same competencies in the basic foundations of healthcare that are expected of physicians. The change in the MCAT and its consequences on the college and university curriculum that prepares students for the test will affect students preparing for careers in other health professions as well.

MOVING FROM PREREQUISITE COURSES TO COMPETENCY-BASED ASSESSMENT

The basis for much of the change leading to the revised MCAT extends from two recent reports on the foundations of preparing future physicians. The first one, Scientific Foundations for Future Physicians, is a report of a committee of representatives from the Association of American Medical Colleges and the Howard Hughes Medical Institute (Association of American Medical Colleges–Howard Hughes Medical Institute 2009). This report emerged “largely from the concern that premedical course requirements have been static for decades and may not accurately reflect the essential competencies every entering medical student must have mastered, today and in the future.” The report then goes on to focus on the competencies that are required in the premedical curriculum, and makes the case
for the ways in which the MCAT should be used to assess these competencies. The second report, Behavioral and Social Science Foundations for Future Physicians, identified those competencies that an entering medical school student should have in the behavioral and social sciences (Association of American Medical Colleges 2011). As the report states, “A complete medical education must include, alongside physical and biological sciences, the perspectives and findings that flow from the behavioral and social sciences.”

These reports represent bold transformations of the expectations of the competencies of incoming medical students. Not only is there now to be a focus on gaining competencies, as opposed to mastering a set of prerequisite courses, but the areas of education and experiences are expanded much more significantly into the behavioral and social sciences. In equal measure, these documents form the foundation for changes in the academic preparation of students whose career aspirations are in other health professions. Whether a college student pursues a career in medicine, dentistry, or another health profession, these competencies are critical to his or her future success. Most of the other major health professions have undergone similar transformations in their approaches to competencies and curricular reform. In the dentistry profession, for example, our association has adopted a set of “ADEA Competencies for the New General Dentist” (American Dental Education Association 2008), which includes new competency domains in critical thinking, professionalism, communications, and interpersonal skills, in addition to the more traditional competencies of patient care, health promotion, and practice management. We also have an established an ADEA Commission on Change and Innovation in Dental Education to provide a national forum to address issues of contemporary issues in curricular design and reform (Kalkwarf, Haden, and Valachovic 2005).

A COLLABORATIVE ACADEMIC APPROACH TO THE CHANGING HEALTHCARE ENVIRONMENT

The traditional focus on premedical education in colleges and universities, and the primary roles that physicians have commonly played in the healthcare delivery system is undergoing a dramatic and comprehensive review. As healthcare reforms begin to be implemented, either because of government intervention or economic necessity, there is a concerted effort underway to rethink the concept of collaborative approaches to healthcare delivery and the education of all health professionals. In 2009, six organizations representing schools of health professions began a process to develop basic competencies for interprofessional education, with support from three private foundations. Two reports were then released that recommended these new competencies and action strategies to implement them in institutions across the country. The intention of these strategies is to transform the current healthcare system to provide collaborative, high-quality, and cost-effective care to better serve every patient.

The first report, Core Competencies for Interprofessional Collaborative Practice, was produced by an expert panel convened in 2009 by the Interprofessional Education Collaborative (IPEC), a unique partnership of six associations (see fig. 1) representing academic institutions in dentistry, medicine, nursing, osteopathic medicine, pharmacy, and public health (Interprofessional Education Collaborative Expert Panel 2011). Interprofessional education, as defined by the World Health Organization, involves shared learning among students from two or more health professions. The panel identified four domains of core competencies needed to provide integrated, high-quality care to patients within the nation’s current, evolving health care system (see fig. 2). It also identified thirty-eight specific subcompetencies that describe the essential behaviors across the four domains. The second report, Team-Based Competencies: Building a Shared Foundation for Education and Clinical Practice, was the result of a 2011 conference, brought together leaders from various health professions to preview the core competencies presented by IPEC, and create action strategies that would use them to “transform health professional education and health care delivery in the United States” (Macy Foundation 2011).

There has subsequently been considerable activity on the interprofessional education front. The chief staff officers of the members of the IPEC meet on a regular basis to address common issues across the professions. Two faculty development institutes are being held in 2012 to bring together representatives of different professional schools at nearly one hundred academic health centers to enhance cross-campus collaboration and the implementation of the curricular and logistical changes required to transform independent academic programs into a true interprofessional approach to educating future health professionals. The Institute of Medicine (IOM) is now in the middle of conducting a multiyear set of workshops through the IOM Global

FIGURE 1. THE INTERPROFESSIONAL COLLABORATIVE (IPEC)

- American Association of Colleges of Nursing
- American Association of Colleges of Osteopathic Medicine
- American Association of Colleges of Pharmacy
- American Dental Education Association
- Association of American Medical Colleges
- Association of Schools of Public Health
Panel on Innovations in Health Professional Education (Institute of Medicine 2012). As more schools of the health professions adopt an interprofessional education approach, the more likely it is that the curricular changes that may result from the implementation of the new MCAT will impact other health professions as well.

**COLLEGE AND UNIVERSITY STUDENTS PREPARING FOR CAREERS IN THE HEALTH PROFESSIONS**

It is always a challenge to identify the size of the cohort in colleges and universities that are preparing for a career in medicine or one of the other health professions. There is abundance of health professions that are recruiting students into their academic programs, some of which require only a few months of postsecondary education and some of which require ten or more years of postsecondary education. If we consider only those eight professions that generally require a professional doctoral degree for initial licensure, there are 50,000 first-year slots (see fig. 3) for these students in the respective US health profession schools. If we assume that there are about two applicants for every first year slot in these professions, then there are about 400,000 college and university students throughout the four years of the prebaccalaureate student body in the United States. As large as this number is, it considers only those students preparing for these eight health professions, and does not consider those preparing for advanced-level degrees in such professions as nursing or physical therapy.

The implications of the MCAT changes need to be considered for their impact not only on premedical students, but also on this large number of students preparing for careers in the health professions other than medicine. The changes in the MCAT are intended to prepare individuals to have a more rounded college experience that will result in more compassionate physicians with skills in critical thinking and lifelong learning. Whatever changes are made to the college curriculum to prepare these students will impact students considering other health professions as well. This is generally perceived as a positive event for all students in the health professions, as we hope to prepare all students for the same changes in the healthcare system, and the same attributes are expected for all providers of healthcare in the future. These common attributes will be critical to ensuring that the future of team-based, collaborative healthcare is realized.

**FIGURE 2. IPEC RECOMMENDATIONS FOR FUTURE HEALTH PROFESSIONALS**

The IPEC panel recommends that the future health professional be able to

- assert values and ethics of interprofessional practice by placing the interests, dignity, and respect of patients at the center of healthcare delivery, and embracing the cultural diversity and differences of health care teams;
- leverage the unique roles and responsibilities of interprofessional partners to appropriately assess and address the healthcare needs of patients and populations served;
- communicate with patients, families, communities, and other health professionals in support of a team approach to preventing disease and disability, maintaining health, and treating disease;
- perform effectively in various team roles to deliver patient/population-centered care that is safe, timely, efficient, effective, and equitable.

The National Association of Advisors for the Health Professions (NAAHP) represents the college and university faculty and administrators who advise students preparing to apply to medical schools and to schools of other health professions. Traditionally, they were often referred to as the “premed” advisors, as their focus often was on working with applicants to medical school in what was seen as a highly competitive environment. As other health professions have become more attractive as career choices, these advisors have generally become much more amenable to providing equivalent advising support for students preparing for other health professions. In articles that have appeared in The Advisor, the journal of the NAAHP, concern has been expressed about the direction that the revised MCAT will take in moving to a focus on competencies rather than courses, the challenges that non-science majors will have in meeting the competencies, and the impact that the revisions will have on colleges and universities in meeting the expectations of the MCAT revisions (Begley et al. 2011). These concerns are appropriate and are sure to lead to further dialog between the advisors and the medical education community. From the perspective of other health professions, this may actually be a desirable outcome of the process leading to the revised MCAT. The traditional approach to preparation for medical and most other health professions schools—satisfying a list of prerequisite courses—is unlikely to provide the opportunity to assess the competencies of a prospective applicant to meet the demands of tomorrow’s healthcare providers.

**STANDARDIZED TESTS AND THE CONCEPT OF “HOLISTIC ADMISSIONS”**

It is generally accepted that standardized tests, such as the MCAT and the dental equivalent, known as the Dental Admissions Test (DAT), have a clear role to play in the evaluation of applicants to various educational programs, but these tests are mostly predictive of first-year success and not necessarily much further
beyond the first year (Sackett, Borneman, and Connelly 2008; Shultz and Zedeck 2011). While these standardized tests are valuable in the assessment of applicants, the question routinely arises regarding the weight that these tests should be given in the final consideration. Most schools of the health professions could accept a scientifically qualified class of new students simply by taking those applicants with the highest overall GPA, the highest science GPA, and the highest MCAT or equivalent admissions test scores. These students will likely perform well in the basic sciences and may actually perform well in the clinical sciences. But are they most likely to become the healthcare providers with the competencies needed to provide the most compassionate and contemporary care in the future? This is especially a concern for those applicants from underrepresented minority and educationally disadvantaged backgrounds who may become future leaders in the health professions, but whose early academic preparation might not provide them with the skills needed to be successful test takers.

There has been an effort in recent years to reassess the way in which many health profession school applicants are assessed that takes multiple attributes into account that are well beyond those provided by college GPA and standardized test scores. This new approach, often referred to as “holistic admissions” or “full-file review,” provides evaluators with much more information about an applicant’s life experiences and competencies that go well beyond test scores. The Association of American Medical Colleges’ Holistic Review Project is a program that uses workshops directed at medical school admissions committees go beyond academic indicators of success and also to take personal factors into account when evaluating minority applicants. At the American Dental Education Association, with funding from the Robert Wood Johnson Foundation, we have initiated an Admissions Committee Workshop program designed to enhance the ability of committees to assess applicants through a more holistic approach.

Through pre- and post-workshop surveys of participants, we have been able to demonstrate success at improving the evaluation of applicants to dental school (Price, Wells, Brunson, Sinkford, and Valachovic 2011). While the process of introducing revisions to the MCAT has become the focus of considerable work of many individuals in medical education and in colleges and universities, it is essential to remember that standardized tests are valuable in assessing applicants to schools of the health professions, but that there are many other nonacademic factors that are also valuable in the assessment of an applicant.

**CONCLUSIONS**

The revisions to the MCAT are important steps in a much more substantial overall reassessment of the appropriate competencies for applicants to medical school and the way in which the test can assess those competencies in an appropriate way. The impact of the revisions is manageable and should improve the curricular offerings in colleges and universities that prepare students for medical school. These steps are important for all of us in the health professions. The competencies of future physicians that are driving the revisions are the same competencies that will be required of future dentists and other health professionals.

**REFERENCES**


Preparing for the New MCAT: The Perspective of Advisors

The last time the Medical College Admission Test (MCAT) was substantively revised was in 1991—ancient history to today’s premed students, most of whom had not yet been born. The same is true for premed advisors, most of whom had not yet been hired. Changing the MCAT, long a bedrock of premed advising, has been tantamount to causing an earthquake that is altering a landscape we thought we knew. The new version of the MCAT, dubbed MCAT2015, is barely on the horizon for current premed students but has already generated much angst among premed advisors.

The current MCAT consists of four sections—physical sciences, biological sciences, verbal reasoning, and a writing sample—that test knowledge of the basic sciences via questions drawn from traditional content areas such as biology, chemistry, and physics. The new MCAT also has four sections, but its sections test interdisciplinary concepts: Biological and Biochemical Foundations of Living Systems; Chemical and Physical Foundations of Biological Systems; Psychological, Social, and Biological Foundations of Behavior; and Critical Analysis and Reasoning Skills. Questions on MCAT2015 are drawn from the intersection between knowledge and skills: to find answers, students must use both their knowledge of the sciences and their scientific inquiry and reasoning skills. To increase score validity, sections of the MCAT2015 will include more questions, lengthening the test from its current 4 hours and 20 minutes to 6 hours and 15 minutes; including breaks and lunch, total time will be about 7.5 hours.

Advisors worry about the impact of a longer test day, possible increased costs, whether their students will be prepared, and about the timeframe for implementing a version for which details are yet to be worked out. Students who will take MCAT2015 are already in college and taking premed courses. Advisors also wonder whether their students will be taught the requisite knowledge and skills in the courses their institutions offer; because MCAT2015 tests interdisciplinary concepts, there is no established list of preparatory courses. In short, MCAT2015 appears innovative, even revolutionary, but many advisors are unsure how to advise their students.

THE MCAT—PAST, PRESENT, AND FUTURE

In transitioning to the new exam, it helps to understand how the MCAT came to be and why it is now changing. Conventional wisdom points to Abraham Flexner’s Medical Education in the United States and Canada from 1910 as the starting point for academic expectations, standardization, and selectivity. Prior to Flexner’s report, there was little to no expectation of an academic foundation for admission to medical school. The report was scathing in its criticism of American medical education and resulted in the closing of many schools, significant changes in curricula, and the development of entrance requirements, including a standardized entrance exam in 1928, which eventually became the MCAT. By the 1940s, entrance requirements had significantly reduced the attrition rate of medical students from an all-time high of 50 percent in the 1920s to 7 percent by 1946.
Since its inception, the MCAT has been more dynamic than students and advisors have realized: it has undergone four comprehensive revisions, along with numerous minor changes, including developing new scoring systems, adding or eliminating content, reducing cultural bias, and in 2007, computer-based testing. MCAT2015 is the current, fifth revision. Not surprisingly for such a high-stakes exam, both major and minor revisions have typically been received with considerable anxiety. It is difficult to discern whether that anxiety arises more from the exam’s predictive validity, its lack of validity, or how its scores are used in admissions.

Over the decades, the MCAT has done well in predicting performance in Step I of the Medical Licensing Exam. Despite numerous studies, however, the data are less conclusive about predicting performance in the clinical years and in becoming “a good doctor.” Educators have long believed that there is more to becoming a successful physician than the ability to do science well, and both educators and admissions committees have sought ways to measure those elusive qualities, often called noncognitive variables. The importance of qualities such as cultural competence, understanding the social determinants of health, and appreciation of broader issues such as ethics are affirmed constantly even as debates continue over how to measure them, but the lure of metrics when evaluating vast numbers of applicants remain. Premed advisors have been keenly aware of mismatches between exceptional students and exceptional MCAT scores.

Recently, the Association of American Medical Colleges (AAMC) has launched numerous initiatives to explore solutions to this dilemma. In 1998, the Medical School Objectives Project identified the skills, attitudes, and knowledge that all graduating medical students should have. Educators have also been concerned about the information explosion and the increasingly rapid rate at which new knowledge is revising science. In response, the AAMC and the Howard Hughes Medical Institute identified what graduating physicians need to know about the natural sciences.

Their 2009 report, Scientific Foundations for Future Physicians, recommended a paradigm shift from fulfilling course requirements to building subject competencies on the theory that it will allow students with diverse educational backgrounds the greatest flexibility in preparing and demonstrating their suitability for a career in medicine.

And in 2011, Behavioral and Social Science Foundations for Future Physicians recommended incorporating behavioral and social sciences. With these three reports as backdrop, the Fifth MCAT Review (MRS) committee began its work. The result is MCAT2015, a competencies-based exam that tests both knowledge and skills in the natural and social sciences.

In some respects, we have come full circle, in that one of the most radical changes of MCAT2015, the inclusion of social sciences, has precedents in the MCATs administered between 1946 and 1977. From the beginning, there were complaints that those sections were culturally biased and that admissions committees paid them only lip service, according greater emphasis to natural science scores. For over thirty years, MCATs have focused on the natural sciences; it will be interesting to see how admissions committees use the four scores from MCAT2015.

What is abundantly clear is that changes in the MCAT are part of a ground swell transforming the educational landscape: technology and the information explosion; new educational theories; student learning outcomes and competencies instead of coursework. MCAT2015 is just one initiative among many to improve how medical schools evaluate, select, and educate tomorrow’s physicians: systems- and problem-based learning curricula; holistic admissions processes; and new evaluation tools such as the Personal Potential Index (PPI), Multiple Mini-Interviews (MMIs), and clinical scenario-based interviews. The MCAT is only one tool in a complex selection process that includes academic records, service, life experience, ethics, interpersonal skills, and professionalism.

The most pressing concerns for advisors revolve around identifying which courses will cover the material necessary to achieve the competencies. While competencies-based curricula are being developed, and may become commonplace at well-resourced institutions, they are not now in place at most schools. Advisors have been put in the position of advising students on MCAT2015 competencies with no clear-cut guidance on how or even whether medical schools will evaluate those competencies for admission purposes beyond performance on the MCAT. The advising community and undergraduate institutions recognize that competencies are powerful principles in guiding admission criteria, but the heart of education at undergraduate institutions is courses. Undergraduate courses provide students the opportunity to acquire the knowledge and skills that lead to competencies, and students’ performance in those courses can measure, to at least some extent, whether competencies have been acquired.

**PREMED COURSES NOT YET REVISED**

While a specific list of premed courses, agreed upon by medical schools, would ensure consistency in advising, that appears unlikely. Most medical schools have not, or at least not yet, revised their prerequisite courses in light of MCAT2015, leaving students in the unenviable position of having to fulfill both prerequisites for medical schools as well as competencies...
for the MCAT. There should be substantial overlap between the two, but course content varies considerably between different institutions, especially in the social sciences.

To be fair, the idea that courses taken for the current MCAT cover everything tested is pure assumption. Having a list of courses has lulled institutions, advisors, and students into complacency; if students do not perform well on the MCAT, it must be the fault of students, not courses. Moving to competencies for MCAT2015 has exposed that assumption, making institutions and faculty uncomfortable. That courses vary from institution to institution is hardly news, but requiring competencies has shifted the responsibility for addressing discrepancies in the material covered from the AAMC, test-makers, and medical schools to individual institutions. The AAMC has made clear what knowledge and skills medical schools want applicants to have, and now each institution must decide what its courses do and do not cover. The looming question is who is, and who ought to be, making that decision. Some institutions have administrators and faculty engaged in determining answers; others have left the decision to their advisors, many of whom have no way of knowing which topics are covered. The MCAT2015 competencies can help institutions determine whether their courses are teaching what will be tested, but whether faculty will adjust their courses is quite another matter. As one professor snapped, “It’s not my job to teach for the MCAT.”

**MAPPING COURSES TO THE MCAT2015 COMPETENCIES**

However the decision is made, time is running out. Changes and information are still rolling out, and advisors have little time to communicate them, adjust their advising materials, and work with their faculty to map courses to the MCAT2015 competencies. Some advisors have requested that the AAMC delay implementation but acknowledge that the AAMC has already spent years on this initiative and that no length of delay will be adequate to ensure everyone is ready.

Premed advisors are also concerned about how the move to competencies will impact non-traditional and disadvantaged populations. Will less privileged populations have the social, experiential, and financial resources to navigate less clearly defined ways of preparing and to acquire competencies that require more than just coursework? Will preparing for MCAT2015 require the guidance of a dedicated, trained premed advisor, expertise that is unavailable at many institutions?

Some advisors have pointed out that although medical schools emphasize that they value all majors, additional requirements limit options. Non-science majors already have difficulty meeting current requirements; with the new set of requirements estimated conservatively at over 40 semester credits, the choice of majors that can be completed within four years will assuredly decrease. Advisors are also worried that requiring psychology and sociology will displace other health-related electives such as human development, nutrition, the ethics of health care, topics in public health, etc., further constraining the diverse paths students take in preparing for a career in medicine. Reducing the goal of understanding psychological, emotional, and sociological aspects down to a couple of introductory courses in sociology and psychology seems counterproductive. At many undergraduate institutions, there are a variety of behavioral science classes that do not require introductory psychology or sociology as prerequisites, and students are often able to take pertinent higher-level courses as electives.

There is widespread concern in the advising community that additional coursework may make it increasingly difficult for premed students to graduate in four years. There is an underlying fear that MCAT2015 will prove to be simply “more”: more courses, more credits, more extracurricular activities, and more time to graduation, at a time when institutions are focused on graduating students within four years. As yet, no one knows how many of which courses will be needed for MCAT2015; institutions and advisors have been hesitant to commit to a specified list while exam details are still changing. The more cynical advisors have wondered whether reconfiguring requirements into competencies is a way to increase requirements without the AAMC having to be the one to announce a longer list of required courses.

Finally, advisors are concerned that MCAT2015 will become even higher stakes than it already is. With the current MCAT, a weaker MCAT score can sometimes be offset by strong grades in the subject areas the MCAT purports to test, and vice versa. With MCAT2015, grades and scores may not serve as a cross-check, and a weaker MCAT2015 score may imply incompetence, whatever the student’s grades. In short, the fear is that MCAT2015 will be perceived as even more critical for the already highly competitive and hyper-achieving premed population.

**THE MCAT AND THE NATIONAL ASSOCIATION OF ADVISORS FOR THE HEALTH PROFESSIONS**

Throughout the process of developing and transitioning to a new MCAT, the AAMC has been responsive to advisors’ concerns, and the feedback loop between the AAMC and the National Association of Advisors for the Health Professions (NAAHP) has improved the process for all concerned.

Institutions are responding to the MCAT2015 in a variety of ways, ranging from rethinking curricula and creating premed tracks to no response, or at least waiting until someone takes the lead by publishing a list of recommended
courses. Some institutions are piloting interdisciplinary programs that will allow premed students to obtain MCAT2015 competencies as part of their major; others are exploring ways to incorporate biochemistry into existing premed courses. The institutions of greatest concern are those without a dedicated, trained premed advisor to coordinate the response and manage the information flow, and the many community colleges, which are often staffed by generalist advisors and may not see a need to respond, since their students take the MCAT2015 after transferring out. Institutions that receive large numbers of transfer and community college students will need to work with their feeder schools to avoid an increase in their students’ time-to-graduation. Institutions that have premed advisors and large populations of premed students are responding proactively, using MCAT2015 as a catalyst to discussion and to updating curricula, as shown in the following reports, written by health advisors at the given institution.

Tufts University
The advisors at Tufts have been following the new MCAT with interest. This past summer, we met with our science chairs and premed committee. Introductory courses at Tufts already delve deeply into material, cover most of the competencies, and have high expectations for critical thinking, and we feel our students will be well prepared for the new exam. Our challenge is to meet the needs of premed students while maintaining the integrity of our courses and serving the needs of our other science majors. Faculty in the physical sciences are considering incorporating more examples from the life sciences as a way to make the subjects more relevant to premeds. The chemistry faculty are hoping to modify their usual course sequence from two semesters of inorganic plus two semesters of organic chemistry to two semesters of inorganic chemistry, incorporating some organic chemistry, plus one semester of organic chemistry followed by one semester of biochemistry. Chemistry majors will take an additional organic chemistry course covering synthesis, and biochemistry majors will take additional biochemistry courses; these latter courses for physical science majors will likely be much smaller, affording a more intimate, engaging experience. For the social sciences section, we do not want automatically to require introductory psychology and sociology. Many courses at Tufts address the social determinants of health, cultural competence, and more; this coming year, we hope to suggest a list of courses with additional preparation materials.

Colgate University
We have been proactive in providing information to faculty and students, including periodic updates to relevant departments and the Dean of Faculty. We have also engaged in ongoing dialogue with our Health Sciences Committee about the implications for advising students on when to take the MCAT. MCAT2015 has been a regular topic of conversation, particularly with the classes of 2015 and 2016. We strive to identify resources that will help our students not just prepare for the MCAT, but for their careers as physicians. Our premed students are advised to take at least one course in biochemistry, and our chemistry department recently began offering the foundational biochemistry course every semester, along with additional biochemistry options. Premed students can gain competency in statistics through a variety of departments, including mathematics (introductory and upper-division), biology, and psychology (both as part of the major requirements). Our premed students have long been advised to take courses in the behavioral and social sciences, many of which will also fulfill distribution and core requirements. We are in the process of mapping the foundational concepts of MCAT2015 to our courses, and our faculty will look to their professional organizations for guidance about possible changes in curricula.

Auburn University
At Auburn University, we formed an MCAT Committee that included both the former and new associate deans for Academic Affairs, the director of Pre-Health Programs, as well as faculty from the biology, chemistry, and physics departments. We also included both students who have done well on the MCAT and students who have not. Our committee was charged with identifying ways to help students prepare for the 2013 changes in the current MCAT—the omission of the writing section and the inclusion of experimental questions for MCAT2015—and for the new MCAT in 2015. We began by conducting a detailed review of current test content and then discussed the proposed changes for MCAT2015. We compiled a list of suggestions and appointed subcommittees to discuss ways to modify student attitudes and behavior when preparing for the MCAT; to supplement or modify our courses in order to add online MCAT content; to identify best practices for test preparation; and to consider changing our current advice about when to take the MCAT. Our MCAT committee met in mid-October to review suggestions and formulate an action plan.

University of Hawaii at Manoa (UHM)
At UHM, the Vice Chancellor for Academic Affairs convened our MCAT2015 Committee and appointed as chair the associate dean for medical education at our medical school. Our committee included the medical school’s director of admissions, the deans of the Colleges of Natural and Social Sciences, faculty chairs from biochemistry, biology,
chemistry, mathematics, physics, psychology and sociology, and the Director of UHM’s Pre-Health/Pre-Law Advising Center (PAC). Our VCAA charged the committee with identifying which courses our premed students will need to prepare for MCAT2015 and with evaluating whether to formalize our premed track. Over the summer, we conducted a survey mapping UHM’s courses to the MCAT2015 competencies. Completed by teaching faculty and then corroborated and adjusted by students who have taken the courses, the survey yielded a list of recommended premed courses. The survey also indicated that covering all of the competencies would require significantly more courses than currently required. Responses from social sciences faculty included an unsettling number of “maybes,” depending on who taught the courses, and it was not at all clear that standardizing course content would be in best interests of our students or of the departments’ majors. We are still finalizing the results of the survey and are hoping to issue a list of recommended premed courses, as well as electives that go beyond MCAT competencies. Once that is in place, we will focus on re-examining our premed track.

CONCLUSION
Despite their many concerns about MCAT2015, most advisors welcome broadening the premed curriculum, in hopes it will better prepare students for careers as physicians. As we move toward implementation, there has been an outpouring of resources, creativity, and generally cooperative spirit among members of the advising and medical school communities. The AAMC has provided myriad resources—publications, including the essential Preview Guide; webcasts; and websites—to help students prepare and to help advisors and faculty determine how the competencies can be met through courses. The NAAHP has partnered with the AAMC to disseminate those resources online and through regional and national conferences. In general, the process has been admirably transparent and has initiated much-needed dialogue at institutions across the country, dialogues that are yielding innovative curricula.

Many premed advisors and students are still unaware of the coming changes, and many who are aware are anxious over the concerns raised. That “things will be different” for all concerned is certain, but exactly how is less clear; the AAMC and advisors frequently find themselves answering, “We don’t know yet.” One major unknown is how MCAT2015 will impact medical schools’ prerequisite courses. What we do know is that problems will shift, some fading, others persisting, and new ones appearing. For now, NAAHP advisors are focused on collaborating to resolve problems, facilitating the flow of information, and teaching their students how to navigate a changing world.

REFERENCES
AAC&U Work on STEM Reform

Project Kaleidoscope
Since its founding in 1989, Project Kaleidoscope (PKAL) has been one of the leading advocates in the United States for building and sustaining strong undergraduate programs in the fields of science, technology, engineering, and mathematics (STEM). With an extensive network of nearly 7,000 faculty members and administrators at over 1,000 colleges, universities, and organizations, PKAL has developed far-reaching influence in shaping STEM learning environments that attract and retain undergraduate students.

PKAL accomplishes its work by engaging campus faculty and leaders in funded projects, national and regional meetings, community-building activities, leadership development programs, and publications that are focused on advancing what works in STEM education. In 2010, PKAL became the STEM leadership unit within AAC&U, building on a shared vision of shaping leadership environments that prepare all undergraduates to address the scientific and technological challenges they will face both as citizens and in the economy.

Leadership for Interdisciplinary Learning: A Practical Guide to Mobilizing, Implementing, and Sustaining Campus Efforts
Many institutions are working to create interdisciplinary learning environments and opportunities for students to organize their studies around societal and global challenges and problems. Leadership for Interdisciplinary Learning provides a framework for evaluating institutional progress in implementing interdisciplinary learning. It provides a roadmap for mobilizing, implementing, and sustaining interdisciplinary programs. Based on the experiences of twenty-eight colleges and universities in the Keck/PKAL Facilitating Interdisciplinary Learning project, this guide is designed in a process flow from planning to institutionalization framed with key questions that should be asked during each phase of program development. A publication of Project Kaleidoscope (PKAL), this guide reflects efforts based within the STEM disciplines but is applicable to other disciplines as well, providing an organizational framework to help campus leaders anticipate and address the infrastructural issues that can impede long-term interdisciplinary program sustainability.

2013 PKAL Summer Leadership Institutes for STEM Faculty
Baca Campus of Colorado College
Crestone, Colorado

The PKAL Summer Leadership Institute is designed for early and mid-career STEM faculty engaged in leading projects aimed at transforming undergraduate STEM education in their classrooms, departments and institutions. These five-day intensive institutes provide faculty participants with the theory and practice required to act as agents of change in their home institutions or professional societies. They are held in the heart of the Rocky Mountains at the Baca Campus of Colorado College in Crestone, Colorado. PKAL is in its 15th year of offering the Summer Leadership Institutes.
The 2009 AAMC–HHMI Scientific Foundations for Future Physicians report (SFFP) broke new ground in proposing a realignment of premedical and medical education around specific scientific competencies needed for medical practice. A competency-based approach has exciting implications not only for improving premedical education, but also opportunities for transforming undergraduate science education generally. If premedical course prerequisites and MCAT preparation have historically been viewed as restricting the flexibility of curricular revision efforts, the current discourse contributes to a more receptive context for broader reform across the science disciplines. The impact of the SFFP on premedical education lies in the potential of its recommendations to inform curricular reform in undergraduate science education and facilitate pedagogical innovation.

Several indicators suggest that the landscape is conducive to reform. Medical schools are beginning to examine current standards for admission in response to recommendations to create less-restrictive pathways for students to acquire premedical competencies. Increased flexibility for pre-medical students, who comprise the majority of students in introductory science courses at many institutions, may provide leeway for undergraduate programs to explore new ways to implement competency-based science education for all students. Finally, the revised MCAT itself provides leverage for undergraduate science programs to adopt competency-based approaches to prepare their students: the MCAT2015 will include more questions designed to assess higher order thinking skills aligned with SFFP recommendations.

The SFFP blueprint identifies two specific challenges for premedical education reform that should be addressed by science departments and faculty. First is how to establish curricula to develop student knowledge and skills across traditional disciplinary borders. The SFFP argues that “the need for increased scientific rigor and its relevance to human biology is most likely to be met by more interdisciplinary courses.” For instance, how might students best develop the ability to “apply basic physical principles to understand living systems,” when “basic physical principles” and “living systems” are typically taught in separate courses controlled by different departments? Interdisciplinary approaches will involve cross-departmental faculty conversations, as well as institutional support to develop new connections, perhaps even new courses that span traditional departmental boundaries.

Second is how to develop appropriate assessments to evaluate student competency development. Developing learner competency means providing opportunities for students to practice and demonstrate the skills and habits of mind appropriate to science, that is, an authentic science context. Standard assessment practices prevalent in large introductory lecture courses tend to rely on summative multiple choice exams. Such assessments are mostly limited to content acquisition and lower-order thinking skills and are ill-suited for measuring competency. Competency-based education requires formative assessments that provide ongoing feedback to learners and educators about their progress, approaches with which not all faculty are familiar. Faculty development in learning assessment is a critical element of institutional support for science education reform.

Undergraduate programs are positioned to play a lead role in improving the scientific preparation of future physicians for medical practice. Many educators are already pursuing interdisciplinary approaches and designing learning outcomes aligned with competency development. These pioneering efforts contribute models for other institutions to consider as they seek to implement effective strategies in their classrooms. Sustaining these efforts on the ground depends on strong institutional commitment to improve not only premedical education, but the education of all science students. Taking up the charge means reforming established departmental structures and curricular assessments that have typically focused on discipline-specific knowledge acquisition. More than ever, departmental leaders must acknowledge the need for science education reform and must embrace curricular innovations to improve undergraduate instruction. There is no better time than now.

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