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Reviews of Webcasts

Osteopathic Students and USMLE

Assessing Learning in PBL

Nutrition as Part of the Curriculum

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Letter of Invitation

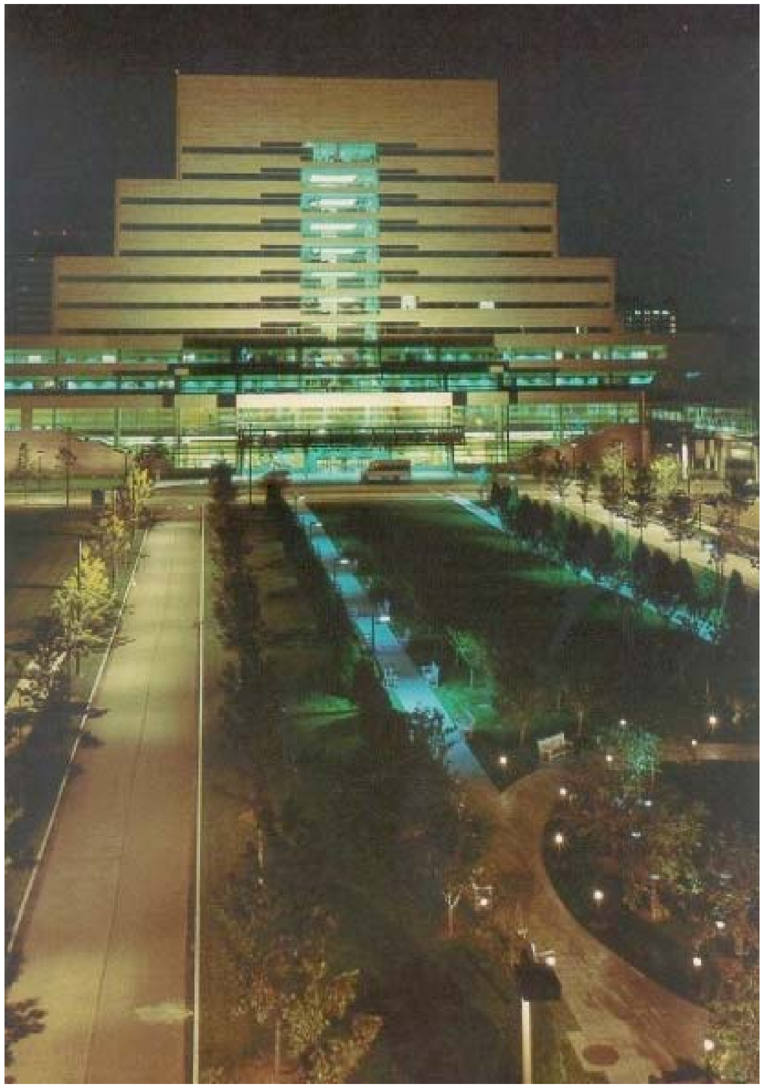
Frazier Stevenson, M.D.
Chair, 2007 Program Committee
Edward P. Finnerty, Ph.D.
IAMSE President

It is our pleasure to invite you to join us for the Eleventh Annual Meeting of the International Association of Medical Science Educators (IAMSE) to be held in Cleveland, Ohio on July 21-24, 2007. This event, which is being hosted and joint-sponsored by "The School of Medicine and the Cleveland Clinic Lerner College of Medicine of Case Western Reserve University", will explore strategies for teaching and learning the fundamental sciences of medicine, with particular focus on the preclinical curriculum. It is directed toward course and clinical clerkship directors; basic scientists and academic physicians; rectors and deans; deans for medical education, academic affairs, faculty development, and CME; educational psychologists; and all those who have interest in more appropriately integrating science within the medical curriculum.

The IAMSE meeting offers you these attractions:

- **A practical program for educators**: The program focuses on issues directly relevant to teaching science within the professional health curriculum. As in previous IAMSE annual association meetings, internationally recognized speakers will set the stage with topics for numerous interactive small group focus sessions and hands-on workshops. Our plenary sessions feature a mix of conceptual background (motivating and rewarding teaching, strategies for teaching communication skills) and practical classroom technique (team-based and case-based learning, integrative strategies for student assessment). Education poster sessions and theme-based poster discussion sessions have been expanded. Twenty small group sessions allow you to interactively share your educational resources and focus on particular topics in education, facilitated by expert faculty. Six Saturday day-long courses in faculty development will address topics such as evaluating educational manuscripts, hands-on use of simulators in teaching basic science, and designing and facilitating team-based learning sessions. The anticipated IAMSE Debate returns to consider the relevance and changing role of the basic scientist in teaching professional health students.
- **Networking:** As global interdisciplinary events, IAMSE annual association meetings attract student and faculty participants from over 30 countries, representing all subject disciplines throughout human, veterinary, and dental medicine. The usual 250-300 participant size is manageable and allows you to get to know your colleagues in a friendly environment. The opening reception, poster sessions and Monday evening IAMSE Gala offer great opportunities to share ideas.
- **Outstanding amenities:** Our sessions will be held in the ultramodern facilities of the Intercontinental Hotel directly adjacent to the Cleveland Clinic. Direct proximity to the teaching facilities will allow opportunities for viewing student research and interacting with Case Western Reserve medical students. The adjacent University Park area is rich in educational and cultural sites, and is the home for some of the best of Cleveland's fine pre-1900 architecture.
- **Cultural opportunities**: Visitors will find that Cleveland has many diverse opportunities for sightseeing, including the Rock and Roll Hall of Fame on Lake Erie, and the renowned Cleveland Museum of Art, newly renovated and

located less than a mile from the meeting site. The summer season of the exceptional Cleveland Orchestra at the outdoor Blossom Festival is also possible.



We cordially invite you to join us this coming July for a professional development experience in the true style of the International Association of Medical Science Educators. Plan your travel schedule to leave on an evening flight or stay overnight on Tuesday, July 24, since we plan a full day of sessions that day. Register before April 15, 2007 to qualify for the reduced rates and remember this year, the Poster Abstract Submission deadline is March 15, 2007.

The Medical Educator's Resource Guide

John R. Cotter, Ph.D.

The Journal of the International Association of Medical Science Educators invites the members of the Association to submit reviews of their favorite Websites to The Medical Educator's Resource Guide. The Journal also accepts reviews written by nonmembers. In this issue of the Guide for example, two of the reviews are written by nonmember students.

The subject related sites reviewed in the Guide are chosen with students in mind. The Guide looks forward to further student participation because student reviewers can identify Websites that posses the qualities students hold in high regard. The members of the Association should encouraged nonmember students and instructors to participate by submitting a review.

Send the submissions to jrcotter@buffalo.edu. Please include the URL and a short critique summarizing the content and utility of the site. All submissions will be reviewed for relevance, content and length. Revisions, if needed, will be made in consultation with the author.

Easy Access to More Than 380 Medical e-Learning Applications. Leiden University Medical Center, Leiden, Netherlands.

http://medischonderwijs.nl or http://medicaleducation.nl

A consortium of Dutch Medical Schools has developed a website directory of medical education lessons that are "self contained interactive learning units with a defined learning goal". The website catalogues "learning units" in both basic medical science and clinical medicine. The "learning units" were developed at several Dutch medical schools and medical institutions worldwide. The site claims a total of 380 "learning units", including animations, case histories, review questions, and links to external websites. The materials are classified by Academic Department, Institution, and Organ System. There is also a keyword search function. At present, most of the instructional materials are in Dutch or English – a user can specify his or her preferred language. The search engine is quick and efficiently displays a list of the retrieved sites with a capsule summary of the contents, language of instruction, and authoring institution. A "user rating" for some units reflects feedback from users, although in most cases this is based on a rather small sample. Based on information available from the search result, a medical student, resident or faculty member can quickly identify appropriate material for self-study or as a learning resource. Once a user has registered and setup a password, all of the catalogued "learning units" are directly accessible for free without a separate password by clicking on the website link. The site has a brief "user manual"; however, few users will need this, as the site is fairly intuitive. Lastly, the website offers RSS feeds to track "What's hot" and "What's new" in medical education. (*Reviewed by Thomas Pisarri, Ph.D. and Floyd Knoop, Ph.D., Creighton University School of Medicine.*)

Electron Micrographs. Loyola University Stritch School of Medicine.

http://library.luhs.org/MedicalStudents.htm

I was recently working through the electron microscopy unit of the computer program used by the medical students to learn about the structure of the cell at the University at Buffalo and wished to buttress my understanding of cell structure by seeing additional examples of the organelles that are found in the cell. As a matter of habit, I logged on to Google Images, and believing in the axiom 'everything is on the Internet' was disappointed by the paucity of high-quality, transmission electron photomicrographs. There were many self titled resources with pages of links, but perhaps as a sign of the times and attitudes, most of the links and resources had either migrated to password-protected sites, were nonexistent, or were just collecting dust, not having been updated in years. It seems the initial enthusiasm and rush to share such images and knowledge online has partly passed. Interestingly, there was no shortage of scanning electron images, perhaps due to their abilities to impress professions and laymen alike. After an exhaustive search however, I located the Loyola Health Science Library's website and a link to electron photomicrographs under the headings "Medical Students SSOM Texts"/ "Special Collections". The images were taken from a binder of electron micrographs used by Loyola medical students. This is a four volume set of photomicrographs that contains 125 labeled images of organelles and cells from a variety of organs. (*Reviewed by William Fleischman, B.S., University at Buffalo.*)

Introduction to Chest Radiology. University of Virginia Health Science Center.

http://www.med-ed.virginia.edu/courses/rad/cxr

The purpose of this website is to provide the reader with a self-guided tutorial on the technique, anatomy, interpretation, and pathology of the chest x-ray. Medical students encounter chest x-ray images on a near-daily basis and having a web-based resource at their fingertips is extremely useful. The website features simplified drawings, actual x-rays, correlation with clinical problems, and questions with answers to test the user's knowledge. It gives information about proper ways to read an x-ray and defines commonly used terminology. In addition, it provides detailed information relative to anatomy, physiology, and pathology and would be a useful resource for both clinical and pre-clinical learning. There are numerous x-ray interpretation sites on the internet, but this site allows the users to go through the tutorial or choose to navigate directly to the section of interest if they have a specific question. This website is an excellent guide to chest x-rays for all levels of training. It easily serves as an easy-to-understand introduction for beginning students, a quick self-study for busy residents, and a refresher for all health care professionals. (*Reviewed by Emily J. Wells, B.A., University of Louisville*)

Online Tutorial for the Pterygopalatine Fossa.

https://www1.columbia.edu/sec/itc/hs/medical/anatomy_resources/anatomy/ppfossa/

This website is an animated tutorial designed to explore the pterygopalatine fossa in an interactive multimedia environment. It was authored by Dr. Ahmet Sinav from Columbia University. This program effectively addresses the anatomy of the pterygopalatine fossa by providing a modular overview of its position, boundaries, communications and contents. A pop-up text box with each module guides the student through the relevant landmarks. The introductory module provides a lateral view of the skull that highlights many of the regions that communicate with the pterygopalatine fossa (such as the orbit, cranial cavity, etc.). The boundaries module is based on a high quality depiction of the lateral aspect of the skull, with roll-over labels for each visible bone. The zygomatic bone can be removed revealing landmarks such as the sphenopalatine foramen and the palatine bone. The communications module is based on the use of an isolated pyramid-shaped model of the pterygopalatine fossa. When clicked, the model is positioned to demonstrate the location of the fossa. Clicking the model a second time removes the model from the skull so the openings in the walls of the fossa can be visualized. Each foramen is labeled on the isolated fossa model and the lateral skull and information regarding the region with which each opening communicates is provided. The content module enables the student to add the structures located within the fossa, including the pterygopalatine ganglion, vidian nerve, maxillary nerve and maxillary artery. Overall, this program is an innovative and useful learning tool for students. It does have several limitations, however. The pterygopalatine fossa is only demonstrated from a lateral view, limiting the program's ability to provide an anatomical perspective for this region. The font size used in the pop-up text boxes is too small to read easily. At times, the program's interface is not intuitive; it is not clear what should be done to move forward in a module. The "show all" button works sporadically throughout the modules. Despite these limitations, the program will be of great benefit for students in their study of this deep region of the head. (*Reviewed by Jennifer Brueckner, Ph.D., University of Kentucky College of Medicine.)*

Learner Centered Education: A Webcast Audioseminar Series for Spring 2005

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ABSTRACT

As educators, we focus significant effort and attention on our teaching. In the Spring of 2005, IAMSE sponsored a Webcast Audio Seminar Series entitled: *Learner Centered Education.* Six nationally recognized experts in the field of student learning presented seminars that helped us refocus our attention from what we do as teachers to what the students do as learners. Audience members for this seminar series included participants from 6 countries and over 25 institutions. Participants were able to listen to the presentation via telephone while simultaneously viewing the presenter's slides in a computer web browser. Following each seminar, the speakers engaged the audience in an interactive discussion on the topic of presentation. Audio recordings of the presentation and discussion as well as copies of the presenter's slides are available on the International Association of Medical Science Educators (IAMSE) web site. These media are currently freely available on the web site for review at http://www.iamse.org/development/2005/was_2005_spring.htm. Each seminar speaker provided a summary of contents and major points of discussion following their presentation. Presented below are these summaries in the order of their presentation.

A Cognitive Perspective on Learning: Implications for Teaching

Geoff Norman, Ph.D.
Assistant Dean for Educational Research
McMaster University, Hamilton, Canada
March 8, 2005

Cognitive psychology has provided many insights into how people learn that can inform our teaching strategies. In this presentation, I reviewed findings from the psychology of learning in five domains:

Memory (learning and remembering): Cognitive psychology tells us that a critical element of human learning is the extent to which the learner can impose meaning on the new material, by integrating it with what s/he already knows. In contrast to computer learning (and old models of human learning like Stimulus-Response conditioning) a major determinant of efficiency and effectiveness of learning is meaning.

Transfer (using old concepts to solve new problems): Despite our intuitions that once someone has learned a concept, s/he will be easily able to access it to solve new problems; psychologists have shown that spontaneous solution rates are typically only about 10-30%, even when the relevant concept is known. However, there are now a number of effective strategies to facilitate transfer. Use of multiple examples is a common element to all; two examples are more effective in learning for transfer than first learning the underlying concept and then seeing an example. Second, the learner must actively engage in searching for the "deep structure" of the example, and again, the best way to achieve this is to see the same problem arise in multiple contexts and to actively engage in comparison and contrast to seek out the common elements

Deliberate practice and its critical role in transfer: Multiple examples are critical for transfer. There are also strategies to sequence examples to optimize their impact. Two strategies are: a) mixed practice, where the examples from different categories are deliberately mixed up and the learner must sort them out, and b) distributed practice, where practice sessions are spread out over time.

Experiential knowledge as a component of expertise: While the concepts of formal knowledge of signs and symptoms, disease mechanisms, etc. are an important part of initial clinical learning, experience leads to the gradual acquisition of multiple examples, and expert clinicians often use similarity to prior learned examples as a first strategy in reasoning, a process called non-analytic reasoning. Expert clinicians do diagnosis in many ways, just as people may recognize an everyday object - it is a chair or a cardiomyopathy because it looks like a chair or a patient with cardiomyopathy.

General strategic skills (problem-solving, critical thinking, reflection, etc.): While we used to think that expertise resulted from the acquisition of general skills (problem-solving, reasoning, etc.), a recurrent finding is that successful solution of one problem is almost uncorrelated with solution of another. This finding, and the futile quest for general processes that learners acquire with expertise, has led to the abandonment of search for general skills. With one caveat, terms like "reflective practice" and "metacognition" appear to be a new generation of general skills. However to date, these "skills" are underspecified, and it is not yet clear whether they can be measured, can be learned, and can be shown to be an important component of expertise.

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Portfolios for Assessing Professional Competence and Promoting Reflective Practice

Elaine Dannefer, Ph.D.
Director of Medical Education Research & Evaluation
Office of Curricular Affairs
Cleveland Clinic Lerner College of Medicine

March 22, 2005

This presentation was a basic introduction to the use of portfolios for assessment and learning purposes. Six major areas were addressed: (1) why one might want to consider using portfolios, (2) how to define and establish a purpose, (3) what to consider when using portfolios for formative and/or summative purposes, (4) what to consider regarding reliability, validity and fairness, (5) examples of portfolio assessment systems, and (6) what processes to address in designing a portfolio assessment system. Also emphasized was the way in which the design of a portfolio system can support and reward reflective practice.

Portfolios, as "purposeful collections of evidence", offer a unique opportunity to assess a broad range of competencies because evidence collected can include a rich array of what a learner knows and can do. This capability makes them particularly useful for hard-to-assess competencies such as professionalism. In contrast to the targeted and final nature of traditional assessments, most portfolio approaches require learners to collect evidence over time and thus result in an autobiography of efforts and achievement. Portfolio systems that give learners responsibility for selecting and self-assessing evidence, identifying and implementing learning plans, promote skills fundamental to "self-directed" learning.

Having a clear purpose is essential to ensuring that the objectives are clear to all participants. Decisions regarding the purpose involve at least four dimensions. First, a portfolio can focus on the process of choosing and reflecting on evidence or it can be demonstrate achievement of outcomes where attention to process becomes secondary. Second, portfolios can target specific competencies or assess a broad range of skills. Third, portfolios offer flexibility in terms of the time period for which evidence is collected. Fourth, portfolios can be used for formative assessments to give feedback, or as summative assessments used to make promotions decisions. Case examples presented illustrated the various approaches.

As with any assessment system, portfolios require rigorous attention to testing standards. Even when used for formative purposes, the portfolio approach requires attention to process so that all learners understand the purpose, find the experience meaningful, and receive systematic feedback. When used for summative purposes, reliability depends in large part on standardizing professional judgment so that decisions are credible and the assessment procedures justifiable. The collected evidence needs to be representative of the types of experiences that are core to the curriculum and proportional to the curricular priorities in order to establish validity. Finally, explicit requirements known in advance, equal assistance in preparing the portfolio and a mechanism for due process ensure that a portfolio system meets standards of fairness.

The formal presentation ended by emphasizing the importance of process issues. Successful use of the portfolio model depends on making the purpose explicit and meaningful to all participants, providing guidelines for constructing the portfolio, engaging both learners and faculty in the reflective practice cycle, and standardizing the review process. Attention to these process issues facilitates building a learner-centered assessment culture that is needed for the successful implementation of a portfolio approach to assessment.

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Learning Styles

Lynn Curry, Ph.D.
CurryCorp Inc.
Ottawa, Ontario Canada

April 5, 2005

The session began with a discussion of the difference between educational preference and educational style. Educational style was further elaborated into affective, cognitive and learning styles. What is known about style and preference as applied to medical education was reviewed:

1. There are reliable cognitive style differences across medical specialties.
2. Among the specialties, family medicine, surgery and psychiatry are consistently differentiable.
3. There are reliable cognitive style differences within specialties depending on their practice type (university teaching versus tertiary/ quaternary care versus community-based primary care.
4. Age and gender have an effect on cognitive and learning styles and instructional format preference.
5. Cognitive style has an effect on academic performance.
6. Learning style differs across specialties.
7. Surface approach learning style is common across all four years of medical school.
8. Surface approach learning style negatively relates to performance. Achieving, strategic or deep approaches positively relates to performance.
9. Instructional format preferences differ across specialties.

There are a range of ways to apply style and preference in medical education:

1. Help learners understand their own styles and become more effective self regulating learners.
2. Let instructors know the range of styles and preferences in their classes and help them develop alternative instructional strategies.
3. Work on style flexibility with both learners and faculty.
4. Use style information to assist with year over year retention issues.
5. Use style information to address issues of underserved specialties and geographic regions.
6. Use style information to assist with recruitment and retention of cultural diversity among students and faculty.
7. Use style information to inform testing conditions.

Flaws exist in the style and preference literature:

1. Conceptual confusion: many overlapping and entirely redundant concepts with different names.
2. Over-generalization based on measurement of one isolated construct, often assessed on only one occasion and with only one instrument.
3. Assigning participants to treatment conditions before completely assessing them for complex constructs.
4. Potentially misidentified styles; i.e. using median or modal scores to divide participants into two equal

groups rather than selecting participants from only the extremes of the contrasting bipolar ranges.
5. Insufficient independence between instructor and researcher/ evaluator.
6. Little variation in the interventions purportedly matched to style.
7. Only one or sometimes no independent measure of behavior change.
8. No attempt to control for interacting and confounding variables such as gender, IQ, ability or initial capability in target behavior, time-on-task, and teacher expectation.

The session concluded with a review of where style contributes to the basic sciences of education:

1. Better application of the basic sciences of education improves most teaching/ learning interventions.
2. There are specific knowledge, skills and attitudes required to master the basic sciences in education.
3. As with anything else, information and an opportunity to practice with feedback are essential to mastery.

The basic educational sciences apply to each step in the educational cycle:

1. Communicate clear learning objectives.
2. Justify those objectives by tight connection to post-instruction application.
3. Match learning objective with appropriate instructional and assessment modalities.
4. Provide detailed feedback to learners on mastery results.
5. Provide guidance on where to focus next (next learning objectives).
6. Provide encouragement to maintain engagement.

Attention to issues of style and preference can assist both teachers and learners in each of those basic educational skills.

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Assessing Learning Environments: Context Matters

Lynne Robins, Ph.D.
Associate Professor
University of Washington
School of Medicine
April 21, 2005

This presentation was an introduction to assessing learning environments as well as a discussion about why contexts for learning matter. We covered four major areas: (1) definition of the learning environment; (2) how learning environments influence students' learning and appreciation of the basic sciences; (3) the iterative use of learning environment assessment for quality improvement; and (4) a brief introduction to learning environment assessment tools.

First, we defined the learning environment as the context in which curricula – both formal and informal are embedded. Then, we distinguished the concept of the learning environment from that of the learning climate, in line with a distinction recently proposed by Genn (2001). Despite the fact that these two terms are used interchangeably, it is the learning climate or the perception of the learning environment by those who function within it that affects students' professional development. The learning climate describes an institution's ethos, or atmosphere. For example, is it stressful, competitive, or supportive? The learning environment refers to readily apparent institutional qualities such as size, the quality of its faculty and students, the number and quality of libraries and laboratories, and the schools' mission. Though important, these institutional features do not influence students' learning and professional development to the extent that climate does.

Next, two studies were presented in support of teaching the basic sciences using learner-centered (rather than teacher-centered) learning formats. Both studies demonstrated that when students learned basic science material in the context of relevant patient cases, they came to value its importance for clinical practice and were inspired to develop lifelong learning skills for the basic sciences. Learner-centered formats, such as problem-based and case-based learning in small groups, provided supportive climates that decreased student stress related to mastering the large body of basic science information required for advancement and fostered positive attitudes towards basic science content and basic science teachers. In contrast, students who went through lecture-based, teacher-centered basic science curricula perceived the basic sciences as a hurdle to be "gotten over" and became increasingly cynical about their relevance to clinical practice.

The speaker then discussed a model for collecting and using learning environment data to guide curricular improvement, based on her experience as former director of curriculum evaluation at the University of Michigan Medical School. Climate data were essential to quality improvement efforts there and that these were collected using locally developed survey instruments and focus groups. To make targeted curriculum improvements, it was necessary to break down the learning environment into its component parts and survey students about each component. To address all students' concerns, it was necessary to conduct subgroup analyses of students' responses. Identifying subgroups of interest is best left to the institution conducting its assessment.

The influence of faculty student-relationships on students' perceptions of the learning environment cannot be overstated. The formal presentation ended by reviewing assessment instruments that are available for use by those interested in pursuing their own interests in this area of assessment and inquiry.

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Concept Mapping – A Tool for Teaching Integrative Thinking

John Pelley, Ph.D.
Associate Professor
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May 3, 2005

This presentation emphasized the utility of concept mapping as an active learning strategy to help students develop integrative thinking skills. An introductory example described how concept mapping played a key role in helping linear learners develop their integrative learning skills producing dramatic results in many students. Several definitions of concept mapping were described to help serve as a context for the presentation. The definitions emphasized concept mapping as an active process, and as a way of reading.

The fundamental unit of concept map anatomy consists of nodes that are linked through relationships. If several links branch from a single node, a hierarchy is created and if cross-links between branches can be discovered, they serve as powerful visualizations of relationships, or in other words, integrative knowledge. The functional anatomy of maps shows that they contribute to all levels of cognitive complexity with simple facts represented by two nodes connected by a link. Branching and cross-linking represent higher orders of complexity, which might be missed in ordinary study.

Concept maps are constructed by: 1) scanning the text and listing the more general concepts, then 2) selecting the most inclusive of these to start the map, usually at the top of the page. Subheadings, or grouping terms, are selected next and branching begins as the map develops its structure. Filling in details and cross-links completes the map. The process can be chaotic for many students since several correct organizational patterns might be possible. Many students benefit initially with support and encouragement in developing their maps, but the need for this is short-lived.

Students should attempt to map all their lecture notes and reading assignments, i.e. any material that is going to be tested. Mapping changes the way they read from linear to integrative. They can also hold highly productive group study sessions by comparing maps. Teachers can use maps to organize lectures, introduce lectures, summarize lectures, emphasize certain points, or facilitate small group discussions. It is possible to score maps so that integrative thinking is highly rewarded, providing an evaluation tool that may have great utility in a PBL curriculum. Also, a method of side-to-side mapping that allows students to cross-link patient data with either answer choices for case vignette questions, or to a differential diagnosis (not discussed), facilitates the development of diagnostic reasoning.

Several barriers exist regarding student motivation to adopt mapping as a learning tool including time requirements, learning style, and mental energy. The speaker recommended teaching sparingly with concept maps with the responsibility for their construction resting with the student. Teachers should do enough mapping to model thinking, but not to do all of the thinking. The magic is not in the map, but in creating it.

Students can be encouraged to share and discuss maps with the goal of enhancing their own maps. Concept mapping is a way of reading because it gives students something to look "for" to replace their habit of looking "at." Mapping even helps integrative learners by increasing their memory for details and helping them stay on task when they study.

Dr. Pelley's Selected Relevant References and Resources

Buzan, T., Buzan, B. The Mind Map Book: How to Use Radiant Thinking to Maximize Your Brain's Untapped Potential. *New York, NY: Penguin Books* USA, 1996.

Novak, J. D. The theory underlying concept maps and how to construct them: http://cmap.coginst.uwf.edu/info/printer.html[Accessed May 13, 2005]

http://www.fed.cuhk.edu.hk/~johnson/misconceptions/ce/learn/concept_map.htm

Issues and Strategies for Student Academic Support and Counseling

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May 17, 2005

Students face high expectations and navigate multiple hurdles to successfully enter health sciences professions educational programs. Successful applicants have impressive records of achievements and relevant experiences that can be interpreted as predictors of educational success in a particular professional education program. Despite the quality of students and the predictive abilities of admissions expectations and criteria, some students encounter academic difficulties during their educational tenure. The purpose of this seminar was to engage participants in examining various aspects of student academic difficulty and to consider the contribution of various models and strategies to predict, prevent, and resolve learner academic difficulties. The following paragraphs summarize several of the main points emphasized in the seminar.

Many schools have established criteria or processes for identifying students who may be at risk for academic difficulty. The professional literature is a rich source of evidence regarding various predictors of academic success. Such predictive variables and strategies are best used as guides rather than definitive labels, gates, or limits on students' expected potential, as learners' academic difficulties may be rooted in multiple concerns (e.g., content deficiencies, ineffective study behaviors, psychosocial concerns, significant events that may occur in personal or family life). Similarly, many factors contribute to one's learning and achievement (e.g., ability, effort, and motivation). Thus, a key point is to get to know students well, both as a cohort and as individuals.

Creating and using proactive systems and practices can enhance all learners' successes, while helping to prevent or minimize learners' academic difficulties. Such strategies can occur within courses, across courses, and at the institutional level. For example, an academic orientation program at the beginning of each year in a degree program can acclimate, prime students for new expectations, and offer guidance for getting the most out of educational experiences. Such programs can incorporate the use of upper level students and alert learners to challenging segments of curriculum and potential areas of difficulty where extra effort may be required. Communicating clearly how learning in one course relates to learning in another is also an example of a proactive strategy. Building strong, explicit relationships across content and learning contributes to meaningful associations and better learning and retention. Finally, students sometimes need help in developing effective methods for being responsible for their own learning – e.g., self-monitoring or use of meta-cognitive strategies (thinking about one's thinking).

Using a systematic approach to educational program evaluation, faculty members can identify course content that is consistently difficult for students to comprehend, alert students, and take proactive approaches to provide support through examples such as supplemental instruction (small group learning), review sessions, and tutoring. Faculty might also identify deficits in prerequisite knowledge or skills and work with colleagues to resolve the problem.

Institutional strategies often include counseling, tutorial, and peer-support programs that cross the curriculum and student cohorts. Such programs may include formal and informal group activities (e.g., tutor or study groups) and individualized interventions (e.g., one-on-one psychological or academic counseling). The effectiveness of such programs depends largely on clear communications and creating safe, low-risk environments so learners take advantage of these resources. At an institutional level, there may be a variety of resources available to students, but if they are not coordinated effectively and if stakeholders (e.g., faculty members, support providers, and learners) are not aware of the resources and how to access them, the potential for benefit and proactive support remains unrealized.

As the culminating seminar of this series, concrete examples and practical strategies were included that drew upon the topics presented in the other five seminars. Specific examples and additional resources were included in the presentation slides and as additional handouts that are available on the IAMSE website.

Dr. Chauvin's Selected Relevant References and Resources

Biggs, J. Student Approaches to Learning and Studying. *Melbourne, Australia: Australian Council for Educational Research Ltd*, 1988.

Mooney, J., and Cole, D. Learning Outside the Lines. *New York, NY: Fireside*; 2000.

Saks, N.S., Zingate, C.M., and Steward, D.G. How to Excel in Medical School. *Alexandria, VA: J&S Publishing*; 1998.

Series Summary

As educators, it is commonplace to focus on what we are doing, how we are teaching, and how we are evaluating our students. This series gave us the opportunity to refocus our attention on the other half of the educational equation: that of the learner. By understanding how students learn, we as educators will be in a better position to help them with the shared goal. Armed with knowledge of learning styles we were then able to explore such topics as learning environments, student academic support, and the difference between learning style, cognitive style and instructional preferences. We then applied this new knowledge to the use of learner-centered tools such as learning portfolios and concept mapping. The principles presented in this series, as well as the examples of learning tools that were given, will be extremely helpful to faculty as they used them to inform their own teaching and learning.

Educational Technology Toolkit: A Webcast Audioseminar Series for Spring 2006

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ABSTRACT

Lecture is no longer the only tool medical educators have at their disposal. The advances in technology and electronic communication have brought about many new tools and more than a few new toys. In the Spring of 2006, IAMSE sponsored a Webcast Audio Seminar Series entitled: Educational Technology Toolkit: A Consumer's Guide. Six nationally recognized experts in the field of educational technology presented seminars on the different types of technology available to medical educators today. Participants were able to listen to the presentation via telephone while simultaneously viewing the presenter's slides in a computer web browser. Following each seminar, the speakers engaged the audience in an interactive discussion on the topic of presentation. Audio recordings of the presentation and discussion as well as copies of the presenter's slides are available on the International Association of Medical Science Educators (IAMSE) web site. These media are currently freely available on the web site for review at http://www.iamse.org/development/2006/was_2006_spring.htm. Each seminar speaker provided a summary of contents and major points of discussion following their presentation. Presented below are these summaries in the order of their presentation.

Electronic Response Systems: Getting Past Gimmick

Susan Batten, R.N., Ph.D. and Carlos Baptista, M.D., Ph.D.
Medical University of Ohio
April 11, 2006

Students arrive on campus equipped with a pocket full of electronic tools; adding one more device to the collection makes sense only if learning increases. Privacy issues are balanced by immediacy of feedback and opportunity to clarify lecture content. Rapid assessment and the capacity to determine consensus makes the Electronic Response System (ERS) a flexible tool for large class sections and meetings.

This session focused on ERS utilization; features to consider in selection; compatibility with existing hardware and software; strategies for smooth implementation; and pitfalls unique to the educational environment. In this one hour audio seminar the presenters identified a variety of systems available; financial and personal investment; effectiveness in gaining student feedback and measuring learning; privacy and security issues; tailoring the teaching and learning experience; and special concerns for faculty.

Finding, Organizing and Using Free Media Resources

Suzanne Stensaas, Ph.D.
University of Utah
April 18, 2006

The objectives of this one hour seminar were to 1) find resources on the Web and keep track of them and 2) create lectures, quizzes and cases that can be freely open for students and faculty at any non-profit educational institution.

Media resources you can use and not abuse is what many faculty want for their lecture the day after tomorrow or their exam tomorrow. Ideally, resources are easy to find, easy to download, easy to store and to retrieve, and of course should be properly credited. This sounds impossible, because university lawyers have many of us totally intimidated about using or sharing anything. The situation is much better than you may think. Better than Google Images and Google Video, you can find and use material managed by the

Creative Commons, http://creativecommons.org/.

During this seminar, we discovered URL Manager Pro, http://www.url-manager.com, if you are on a Mac, and a similar PC utility for managing and nesting bookmarks. We discovered "reusable learning objects" at http://www.healcentral.org where video, animations and images are available for download. HEAL Local, a resource to organized learning objects on your own computer was also discussed. HEAL Local is just being released and found at: http://www.healcentral.org/services/servicesHEAL_Local.jsp, Other image management systems that are simple enough for a novice to use, such as iPhoto (Mac), were also discussed.

Moving from Paper-Pencil to Electronic Exams: What it Takes to Get it Done

Scott Elliott, M.Ed.
University of Iowa
April 25, 2006

This presentation was a basic introduction on how to get started with computer-based testing.

The goal of computer-based testing (CBT) ought to be the use of new and innovative items to measure the proper constructs of learning. Most of CBT activity in medical education, centers on delivering converted paper-pencil multiple-choice exams. If CBT is being used to just deliver multiple-choice exams, one might also consider other testing formats available through CBT. Such formats include patient simulations, script concordance, free text input questions, Computer Adaptive Tests (CAT), and open-ended, short answer, super list questions. With all the available computing power, exam technology should be more creative and more powerful than just delivering converted paper-pencil exams. The following was proposed as a testing hierarchy; starting from the bottom and climbing to the top, the value and computing power of CBT rises:

1. Computer-Adaptive Testing (CAT) (Adaptive Response)
2. Simulations (Constructed Response)
3. Free-Text Input questions (NLP) (Constructed Response)
4. Open-ended, short-answer, Super-List questions (Constructed Response)
5. CBT "page-turners" (MC, TF, selected response exams)

There is considerable growth in the area of constructed response testing systems. They offer benefits such as non-cueing question types that reduce guessing. CAT testing systems adapt to the users skill level in order to present questions at appropriate difficulty levels.

Around the World of Course Management Systems in 60 Minutes - or Less

Matt Christian
Marshall University
May 2, 2006

This presentation was a basic overview of the world of course management systems. It addressed: 1) success factors for implementing an electronic Learning Management System (or eLMS); 2) potential policy and procedure adjustments and recommendations aimed at success of e-learning at an institution; 3) an introduction to a 7-step process for implementing an eLMS; 4) the Marshall Continuum of Delivery, 2) course management system vendors, and 5) suggested methods for evaluating need and selecting vendors for an eLMS.

The presenter discussed the 7-Step process to implement an eLMS:

Step 1: Faculty Needs Analysis
Step 2: Administrative Needs Analysis
Step 3: Technical Analysis
Step 4: Market Analysis
Step 5: Test Drive
Step 6: Procurement
Step 7: Implementation

Formula for Delivering Digitized Lectures: Combine Technology, Faculty Perception, and Copyright Policy then Measure the Educational Outcome

Matt Jackson, Ph.D.
Wayne State
May 9, 2006

This presentation was an overview of the steps required for electronic lecture capture and delivery. It included considerations of: 1) educational outcomes associated with lecture capture and delivery; 2) fair use policy; and 3) intellectual property rights. Different technologies were discussed with the focus on manned videotaping and streaming as opposed to cart-based solutions. The steps required for implementing distance learning initiatives in medical education were discussed. The importance of developing policies to address faculty rights and the Technology, Education and Copyright Harmonization (TEACH) Act were stressed during the audio seminar.

There are advantages and disadvantages associated with providing digital access to lecture material. Isolation of the students who choose to view lecture presentations from home can have a negative impact on the development of communication skills and patient-doctor relationship training. Methods to supplement the preclinical curriculum with small group activities and team-based learning were described during the presentation. Faculty perception is another issue that must be taken into consideration while developing a distance-learning program. Implementation of policies that recognize intellectual property rights of the teaching faculty is a must. Because medical lectures often incorporate copyright protected materials there are restrictions to digitizing the content for web-based delivery. The TEACH Act was passed in 2002 to deal with the increasing amount of educational material that is delivered via the web. The presentation provided an overview of the TEACH Act and the four, fair use factors: 1) character of the use; 2) nature of the work to be used; 3) the amount of work to be used: and 4) potential impact on the market.

There are a variety of technologies available for electronic lecture capture and delivery to serve the needs of medical schools attempting to accommodate adult learners. Some systems capture only the PowerPoint lectures for web-based distribution. Other systems capture audio: iTunes, Podcasting and Vodcasting. These platforms use the QuickTime RSS application to push digitized content to portable devices. The process and rationale behind videotaping and streaming lecture presentations at Wayne State Medical School were described in detail.

Videotaping provides a robust platform for capturing a variety of delivery styles in the classroom. PowerPoints, slides, overhead projections, animations, small group activities, skills training, clinical correlations, and patient panels are all captured on videotape at Wayne State Medical School. A detailed description of the process was described during the audio conference presentation.

Implementing Virtual Microscopy in Medical Education

Bob Ogilvie, Ph.D.
Medical University of South Carolina
May 16, 2006

This presentation began with the emerging literature related to virtual microscopy and proceeded to define virtual microscopy, virtual slides and a virtual laboratory. The presenter then discussed how a virtual slide is created, including digital data in a histological slide. He listed commercial vendors that provide virtual slide acquisition equipment and presented the results of surveys of North American Medical Schools regarding virtual microscopy in teaching histology and pathology.

The presenter shared experiences at the Medical University of South Carolina where, for the past two years, there have been no assigned laboratory sessions in the medical histology course except for the first lab where students learn how to use a microscope, and the difference between digital images, virtual slides and glass slide specimens viewed with a microscope. Students used a web-accessible program, WebMic, to access 1,000 images at different magnifications retrievable from campus or home. As measured by performance on practical exams and positive feedback from students, WebMic has been a success as evidenced by student performance on practical exams and student comments on the system.

The presenter chronicled the teaching of practical histology from a microscope ‘pass-the-slide’ method to videodisc to WebMic. All methods were evaluated by student scores on a microscope ‘pass-the-slide’ exam. WebMic was more effective than the videodisc and required less study/practice time compared to the use of a microscope ‘pass-the-slide’ learning method.

Series Summary

Given the recent advances in technology, any educator would be challenged to keep abreast of the changes. In this Seminar Series, we presented six types of tools that were widely available at the time of the series. These tools were not specific products, but rather categories of tools including: Electronic Response Systems, free media resources, computer-based testing, course management systems, lecture capture and delivery, and virtual microscopy.

COMMENTARY

A Framework for Assessing Different Types of Student Learning Within Problem-Based Learning (PBL)

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ABSTRACT

This article presents an assessment framework for deciding what type of learning or learning outcomes can be assessed and how such assessments can be done in Problem-Based Learning (PBL). The framework is based on Fink's seven categories of significant learning i.e., learning how to learn; motivation/ interest/ values/ respect for others; human dimension; integration/ connection; application/ problem solving/critical thinking; knowledge; and skills. Many opportunities for embedded and easy to conduct assessments of these different types of learning are present throughout the PBL process. The framework presented in this paper can be used to develop a systematic and integrated plan for what learning outcomes will be assessed, how they will be assessed and when. Such a plan can help to make assessments a meaningful and useful learning experience.

INTRODUCTION

Medical educators are now striving to implement competency-based curricula where a broader range of types of learning are considered. Because of this broad range of competencies, faculty members might find a model classifying different types of learning helpful to define and organize the varied competencies required. This article describes one classification system and shows how faculty members can assess students in Problem-Based Learning (PBL) curricula using this classification system.

Current best practice models in higher education[1,2] suggest that there should be an alignment among the goals of the course, teaching/ learning methods and how student learning is assessed. Alignment means that all aspects of a course are integrated or consistent.[1,2] If these three key aspects of curriculum are aligned, student learning is maximized.[1,2] Unfortunately, such alignment does not naturally occur and may be further hindered due to internal (such as the need to create easy to score assessments for many students) and external (such as licensure requirements) forces. As a result, student assessments often suffer from a lack of content validity.[1] Accreditation standards also call for an aligned curriculum. For example, the LCME in ED-33 calls for a "coherent and coordinated curriculum."[3] Among the evidence they require for a coherent and coordinated curriculum is, "methods of pedagogy and student evaluation that are appropriate for the achievement of the school's educational objectives."[3]

Objectives and teaching/learning methods are naturally aligned in PBL.[1] However, in many PBL programs, assessment is not naturally aligned. This manuscript will suggest ways for assessment to be aligned with the objectives and the PBL teaching/learning method according to seven categories of learning being used in higher education.[2]

Seven categories of learning

Fink[2] developed a new approach to considering what students of higher education should learn by developing a taxonomy of seven types of significant learning. These categories, i.e., learning how to learn; motivation/ interest/ values/ respect for others; human dimension; integration/ connection; application/ problem solving/critical thinking; knowledge; and skills, are shown in Table 1. These seven categories are interactive and not hierarchical.[2] Fink'

Table 1. Seven learning outcomes according to Fink's[2] categories of significant learning

	Categories of significant learning						
	Learning how to learn	***Motivation/ interest/ values/ respect for others***	***Human dimension***	Integration/ connection	***Application/ problem solving/critical thinking***	***Knowledge***	***Skills***
Examples of specific learning outcomes by category	Becoming a: • self-regulated, self-directed learner • learner who uses the scientific method • learner who uses evidence-based medical decision making[13]	Developing: • new interests • new values • respect for others • responsibility for one's life	• Acquiring leadership skills • Acquiring an ethical framework for making decisions • Working as a member of an effective team • Learning about oneself • Developing professional behaviors	• Connecting different disciplines, perspectives • Integrating/ connecting ideas, theories • Integrating/ connecting people including coordinating care, networking for colleagues	• Becoming a good problem solver • Becoming a critical thinker using inquiry and analysis • Managing complex projects • Applying theoretical knowledge to patient care	Acquiring: • Conceptual knowledge • Deep, meaningful understanding[1] • Essential knowledge in the disciplines	Developing: • information literacy skills[12] • skills in oral communication • skills in written communication • clinical skills • skills in using technology

approach goes beyond Bloom's[4] taxonomy of three types of learning (i.e., cognitive, psychomotor and affective) because his offers additional types, even though the categories of knowledge and skills in his taxonomy are more inclusive than what is usually assessed. While readers may not always agree with Fink's placement of specific learning outcomes into one of the categories of significant learning, most readers would agree that the individual examples of specific learning outcomes that are listed are worth assessing.

Due to a focus on mostly acquiring knowledge, most content- centered teaching is often one dimensional, whereas Fink's[2] seven categories of learning taken together are multidimensional. Fink's broader classification scheme assists faculty members to move from a content-centered or knowledge driven approach to a learning–centered or competency based approach because it discusses the multi-dimensional possibilities of various types of learning.[5] Reviewers of this taxonomy feel that the interaction among these categories makes the learning significant.[5,6] An official of a regional accreditation agency suggested the use of Fink's categories as a way of developing a comprehensive array of broader objectives and assessments of student learning.[7]

Faculty members across the spectrum of higher education have found that using all seven categories in preparing for a course leads to a broader set of course objectives and assessments[2] and a more aligned course. If medical educators were to employ many of these varied methods of assessment, they might need a way to organize these various assessments into a coherent framework. The current paper uses Fink's[2] categories of different types of significant learning to form the basis for such an organizing framework. Through the use of these categories, educators can plan how, when and why they will assess students on different types of learning within PBL. That is the main purpose of this paper.

Overview on what I mean by PBL: The alignment of objectives, teaching/learning methods and assessment can easily occur within a common model of PBL.[1] PBL is an iterative process. A previous article[8] showed a figure of the PBL process that can be referred to for more information. All material is discussed twice, without prior preparation and then again after researching questions raised (called learning issues). Many of the steps, i.e., discussion of what is known, what is unknown, and raising questions, occurring on the first pass through the material can happen simultaneously. In between PBL small group discussions, students research and synthesize their learning issues and prepare a summary of what they researched, called briefs. The second time the students discuss a part of a problem they should synthesize all that they learned through an integrated discussion of the problem. Feedback should occur at the end of all sessions, and groups need to reserve time for this formative assessment to occur. Such feedback can provide data for assessing various types of significant learning such as the respect component of motivation, the human dimension component, and oral communication skills. The latter part of this article discusses examples of specific PBL assessments from each of Fink's categories of significant learning.

A recent article in this journal[8] described varied authentic and embedded assessment opportunities during the normal conduct of PBL. Embedded assessment means that assessment of student progress and performance is integrated into the regular teaching/learning activities, whereas non-embedded assessments occur outside of the usual learning process.[9] Embedded assessment occurs naturally within PBL during most of the categories of significant learning because learning and the learning process are demonstrated in classroom settings.[8] Authentic assessments mimic what is actually done in practice. The present paper expands on these types of assessment opportunities to include examples of authentic, application-driven, non-embedded assessments[2] that do not naturally occur during the PBL process. All of the learning outcomes and methods to assess them discussed in this paper are consistent with recent accreditation standards such as LCME [3] and will be discussed later.

An organizing framework for assessment of significant learning categories

An organizing framework, shown in Table 2, helps faculty ensure that all categories of significant learning are assessed and to determine the type of assessments to use for each category. Each row describes a different category of significant learning. From row to row, each column addresses the same criteria, but with different categories of learning. When reading Table 2**,** start with the left column then go across that row. This table and the following text describe one or more examples of a specific learning outcome within each of Fink's[2] categories of significant learning. Table 2 lists how to collect authentic, embedded and non-embedded assessment data for each learning outcome example. These authentic assessments can take many different forms; however, they usually do not take the form of multiple- choice tests. This organizing framework should help course directors and program administrators decide what should be assessed and how assessment can be done.

Table 2. Framework for evaluations showing one specific evaluation example within each learning category

How to read this table:

- Each row describes a different category of significant learning.
- Each column addresses the same criteria, but with different categories of learning.
- When reading Table 2**,** start with the left column then go across within that row.

Outcome Category	**Specific outcome to be assessed**	**Rationale for selection of specific outcome**	**Criteria to determine if this outcome was achieved**	**How to collect embedded assessment data/ who is evaluator**	**How to collect non-embedded assessment data: / who is evaluator**	**Comments**
Learning how to learn	Becoming a self-regulated, self-directed learner	Necessary to remain a competent physician, often mandated by accreditation standards (such LCME ED-5) [3]	Knows he/she needs more knowledge; asks researchable questions; knows when he/she has the answer	Repeated use of scoring rubrics, and assessment forms with Likert scales of these criteria for observations from discussions where students raise questions for further study, review of search strategies used to find the answers to these questions/ self, peers, and faculty.	Surveys of how students spend time, professional reading habits, record what library resources students use and for what purposes/ self report, review of library use statistics/ analysis of users (hits) of electronic data bases / self and faculty	The student may have excellent insight into his/her becoming a self-regulated or self-directed learner.

Motivation, interest, values	Developing respect for others especially members of different cultural groups or those with different belief system	Necessary to be a competent professional, often mandated by accreditation standards (such as LCME ED-21,22[3])	Consistently acts respectfully with all other people	Repeated use of scoring rubrics and Likert scale assessment forms of these criteria for observations of small group discussions, especially while giving and receiving feedback / peers, faculty	Noting through the use of critical incidents and surveys of out of class interactions such as cooperation on group assignments/ peers	Whenever students work together, they can be asked to assess each other on respect. Adequate opportunities to learn how to give feedback and how to assess each other need to be provided.
Human dimension	Developing professional behaviors	Necessary to be a competent professional, often mandated by accreditation standards (such as LCME 19, 23[3])	Use feedback constructively; taking responsibility for decisions and work	Record critical incidents from observations noting changes after feedback in small group activities; repeated use of scoring rubrics and Likert scale assessment forms of these criteria to determine amount of responsibility taken, group functioning, doing what is asked during all small group activities/ self, peers, and faculty	Noting through the use of critical incidents and surveys of out of class interactions/ peers, faculty	Whenever small groups of students work together, they can be asked to assess each other on their developing professional behaviors. Adequate opportunities to learn how to give feedback and how to assess each other need to be provided.

Integration/ connection	Integrating different disciplines, perspectives	Health problems are multifaceted and multi-disciplinary, also consistent with accreditation standards (such as LCME ED-17[3])	Connects individual facts about a patient, the patient's problems, the explanations for the problems to form a coherent picture	Repeated use scoring rubrics and Likert scale assessment forms of these criteria to review concept maps developed; observations of small group discussions/ peer, self, faculty	Given several cases, students identify similarities between the cases and distinguish the differences supporting their answer with evidence and research/ faculty, practitioners	Non- embedded assessments may be similar to traditional types of essay or short answer evaluations
Application/ problem solving	Applying theoretical knowledge to patient care to solve problems	Necessary to be a competent physician, often mandated by accreditation standards (such as LCME ED-6[3])	Determines the appropriate next steps to understand or solve the problem	Repeated use of scoring rubrics and assessment forms with Likert scales of these criteria for review of concepts maps and repeated observations of small group discussions/ peer, self, faculty	Give students a new case and ask them to apply what they learned to the new case, or analyze new data on patient follow-up or consider new research or alternative treatment for patient/ faculty, practitioner	Non- embedded assessments may be similar to traditional types of essay or short answer evaluations

Table 3. Where each of the categories of significant learning can be assessed during the PBL process using embedded assessments

Categories of significant learning						
Learning how to learn: learning to use self-regulated learning, using scientific method, evidence based decision making	***Motivation/ interest/ values/ respect for others*** : developing interests, values, respect, taking charge of one's life	***Human dimension***: acquiring professional behaviors, leadership, team work skills, learning about oneself	Integration / connection***: integrating perspectives, ideas, theories, people***	***Application/ problem solving/critical thinking***: managing complex projects, applying theoretical knowledge to patient care	***Knowledge***: demonstrating prior knowledge, showing gaps in essential knowledge, conceptual, deep knowledge	***Skills:*** developing information literacy, oral and written communication, using technology
While all aspects of the PBL process can assess students on all 7 categories of significant learning, this category can be especially assessed when the students:						
• raise unknowns • generate learning issues • prepare briefs	• raise unknowns • generate learning issues • provide feedback and peer evaluations • prepare briefs	• generate learning issues • provide feedback and peer evaluation	• discuss what is known • generate learning issues • discuss the case the second time through • prepare briefs	• discuss the case the second time through • generate learning issues • prepare briefs	• discuss the case during both iterations • generate learning issue • prepare briefs	• discuss the case during both iterations of the case discussion • generate learning issue • prepare briefs

Evaluators and specific assessment tools: Table 2 indicates that different people can be the evaluators, but peers and self-assessments are essential to obtaining rich evaluation data. It is valid to use faculty, peers and the learner him/herself as assessors. Peers and faculty can use assessment tools to document their observations showing the evidence or absence of evidence of specific outcomes. The key is to sample enough observations without overwhelming everyone with the assessment process. Students and faculty can rotate in and out of the observer-evaluator role. Faculty, peers, and the learner him/herself can give formative assessments throughout the learning process[8]. Peers are valid assessors of some of the types of learning discussed here because they offer perspectives on student behaviors that the faculty may not be able to access. These different perspectives can lead to triangulation of data, thus creating more complete data. Peers can also offer excellent insights for ways to improve.[8] Peers should not make summative decisions about content mastery nor assign grades.

Following the suggestions made by Blumberg,[8] many of the examples given in Table 2 suggest using the same types of embedded assessment tools, i.e., scoring rubrics[10] and Likert scale assessment forms, because they are very efficient. Likert scales usually have 5 points, ranging from 1= "not at all" to 5= "consistently demonstrating the trait" or "very much". A rubric is a written summary of the criteria and standards that will be applied to assess the student work. A rubric is usually constructed as a matrix with the criteria along the vertical axis and a brief description of the different standards of performance or levels of standards along the horizontal axis. Both Likert scales and rubrics are essential for conducting assessments based on in-class activities because they make the criteria clear and explicit[10]. While scoring rubrics and Likert scale assessment forms are used with every category, the specific assessment criteria employed are different depending upon what particular category of learning is being assessed. Brief narrative comments based upon repeated observations of student performance can further support these rubric or Likert scale scores.

Assessment of all seven of Fink's categories of significant learning within PBL curricula

1) Learning how to learn*:* Evidence of self-regulated learning and taking responsibility for one's own learning can be especially assessed whenever the students are raising questions for further knowledge, such as during the first iteration of PBL discussions of cases. Identifying the need for increased or more in-depth knowledge is an essential part of being a self-regulated learner.[11] Once a need for more knowledge has been identified, students need to know how and when to ask questions.[12] The type of questions raised can lead to different information obtained, as well as varying quality of information. Students can be assessed on their ability to raise good questions and their knowledge about the different kinds of questions during both iterations of PBL case discussions.

Evidence-based decision-making[13] can be assessed whenever the students use their knowledge base, as for example, during the discussion of clinical cases. Students should question the validity of the evidence raised and consider the strength of the research design before reaching any conclusions. The assessment for evidence-based decision-making should follow from the guidelines developed by Sackett and coworkers[13]. Students can also form hypotheses about possible solutions to the problem. These hypotheses might be relevant basic science mechanisms or a differential diagnosis. As shown in Table 1, both evidence-based decision making and use of the scientific method are components of the category of learning to learn.

2) **Motivation, interest, value:** Throughout the small group PBL activities, self, peer and faculty assessments can be made on specific aspects of motivation such as developing new interests, new values and taking responsibility for oneself. An example of developing new values involves the concept that students have developed about diseases and patient care. Beginning medical students tend to be disease-focused in terms of the pathophysiology of the organ system. During further training medical students should begin to develop a more holistic approach that also values the impact of the disease on the patient's ability to function and the effects of societal factors such as health insurance or poverty on the patient's long term prognosis. These changes in values can be observed in small group PBL discussions. Also, after small group PBL sessions it is appropriate to comment on the respect the students show for each other, as well as patient needs (as an assessment of professionalism).

3) **Human dimension:** Specific professional behaviors that can be explicitly assessed at the end of on-going small group PBL sessions include: 1) responsibility: the ability to fulfil commitments and to be accountable for actions and outcomes, such as handing in assignments on time; 2) equal participation: the willingness to take on a fair share of the workload and make meaningful contributions to the group's discussions and not dominate discussions; 3) professionalism: the ability to exhibit appropriate, professional conduct in group meetings; 4) interpersonal skills and the ability to communicate effectively, including speaking and listening; 5) flexibility: the willingness to cooperate with the rest of the group in terms of how the group functions or assignment of roles.[14] These five categories can all be assessed using a Likert scale for each category.

Maritz[15] identified eighteen domains that contribute to professional behaviors and crafted a checklist to assess them. If the phrase "small group" or "PBL discussions" is substituted for the word "clinic", this checklist can be used in PBL discussions. Peers and faculty can rate the students in their small groups on each of these domains using the Likert scale shown in Appendix A.

Another way to assess professional behaviors is to assess the ability of the students to contribute to conditions that support group learning. Faidley, and coworkers[16] identified seven aspects of team work that can be assessed during small group discussions including commitment to the purpose, commitment to a common approach, complementary skills, accountability, team conflict, team performance, and overall team satisfaction. Group members, both students and faculty, can assess these aspects through a 38 item survey using a 7 point Likert scale. (For the actual items in the survey see pages 134-135 of Faidley)[16]. This survey instrument provides information about perceptions of both process behaviors and performance behaviors.

4) **Integration/connection:** Integration and connection among ideas, perspectives, theories and people can be assessed appropriately when students discuss clinical cases after they have learned about the basic sciences involved in the case, such as during the second iteration of PBL discussions. Such discussions can be used to measure the melding of all of the group's collective knowledge, skills in inquiry, analysis and integration. Integration can be assessed using a rubric. One mechanism that fosters a rich, multi-disciplinary discussion is to ask the students collectively to construct a concept map[17] summarizing what they know about the problem or case with this material. Concept maps graphically illustrate the integration of all they know about a problem showing relationships and hierarchies.[17] My experience with concept maps indicates that the groups do more synthesis and group problem solving when they collectively develop concept maps, than when they discuss the problem again without the goal of developing such a product. Concept maps are especially good at evaluating the organization of knowledge into hierarchies, and the associations and integrations among separate details. Generally the group would receive a group grade for their concept map. A further description of how to assess students on their concept maps can be found in Blumberg[8].

5) **Application/ problem solving:** Embedded in PBL discussions of clinical cases, students can be asked to apply what they know about the underlying science to solve patients' problems. Beyond the PBL case discussions themselves, students can be asked to write case summaries individually or give a presentation of a case explaining the basic science issues involved. To make these presentations or written reports more authentic, the students should be given a specific context and an audience such as scientists, other health professionals, or patients. Groups can be given different contexts and audiences to help students to see how they need to communicate the same knowledge differently. For example, a group can make a simulated presentation to a government agency such as NIH, to advocate on behalf of patients with particular types of diseases for increased funding and more basic science research to fully understand the disease process. Another group might make simulated presentations explaining the disease process to patients or to another type of lay audience. These different presentations or reports demonstrate the student level of mastery of the same basic science content. Such an exercise would also assess written or oral communication skills. It has become apparent that these presentations or written reports should only be done periodically, because they are labor intensive and students might concentrate on preparing these presentations or write-ups at the expense of working on new content.

6) **Knowledge:** The proper use of knowledge and evidence of deep learning can be assessed during the discussion of clinical cases. Deep learning is learning with meaning, and understanding, thus forming associations among concepts.[1] The LCME ED-6 uses the concept of deep learning in the context of student abilities to engage in critical judgment and to use principles and skills to solve problems.[3] Students demonstrate deep learning in PBL discussions when they relate the current problem to what they previously learned about similar health problems or when they can select appropriate laboratory tests to order to help to identify the clinical problem. Appropriate knowledge usually relates to the basic science disciplines that are fundamental to medicine. The application of knowledge to the patient's problems can also be assessed.

7) **Skills:** The Association of College and Research Libraries[12] defined five information literacy standards for higher education including: the determination of information needs; the acquisition of information effectively and efficiently; critical evaluation of information and its sources; the incorporation of selected information into one's knowledge base; and the use of information legally and ethically. These information literacy skills can be assessed whenever students are asked to gather and synthesize information from the medical or scientific literature, such as on briefs. These assessments can take the form of small presentations to the class, posters, written papers or even summary of information on an educational website. All of these information literacy skills are integral to become self-directed, independent learners.

As discussed above with application/ problem solving, whenever students are asked to simulate speaking or writing to patients, their families, colleagues and other professionals, they can be assessed on their written or oral communication skills. I have used short letters of referral to another health professional, and written or oral communications about disease process that are intended for patients. Objective Clinical Structured Examinations (OCSE's) can be used to assess oral communication skills.

Description of specific assessments of categories of significant learning during the PBL process

Table 3 shows where in the PBL process each of Fink's [2] categories of significant learning can be assessed. As Table 3 illustrates, many different types of assessments can occur through observations of students engaging in the various steps of the PBL process. Each step or all of the steps together within the PBL process can be used to assess more than one type of learning simultaneously. For example, what students normally do during the steps of raising unknowns and formulating learning issues is congruent with the learning to learn, knowledge, and skills categories. Thus, students can be assessed on these categories of significant learning during these two steps using embedded assessments documenting what occurred in the group discussions.

First iteration of the PBL case discussion. While engaged in raising unknowns and formulating learning issues, students can be assessed on 1) the evidence of their being self-regulated or self-directed learners, 2) demonstration of using evidence-based medical decision making[13] to identify misconceptions or lack of good evidence, and 3) the use of the scientific method while engaged in raising unknowns and formulating learning issues.[18] All of these assessments are within the learning to learn category. Asking good researchable questions is a skill that develops during several steps in the PBL process[8,11] especially during the generation of learning issues. This skill can be assessed at this time. Specific skills can be assessed during the discussion of what is known and raising unknowns including 1) their developing problem solving abilities,[17] 2) the information literacy skill[12] of determination of information needs,[19] and 3) oral communication skills.[18] Most of these assessments would be conducted by faculty.

During these same steps faculty can assess students on specific examples of the knowledge category including their demonstration of prior knowledge, their gaps in essential knowledge, and their understanding of conceptual and deep knowledge.[20] The recall of prior knowledge and gaps in knowledge can be assessed during the first iteration of the case discussion. The step of generation of learning issues is ideal for self, peers and faculty to assess the students' ability to define an information need and to determine the appropriate resources to use to answer their questions.[11]

Assessments from briefs*:* In between PBL group sessions the students research their own learning issues or questions. Students can prepare a brief (short summary, at most one to two pages including graphs or figures, written in bullet points or outline) for the information they acquired to address the learning issue, plus a list of their information sources. Blumberg[8] describes ways briefs can be used and assessed by peers and faculty. The process of developing briefs forces students to synthesize their knowledge, reflect on their learning, and it serves as a check as to whether or not the learning issues were addressed.[8] Table 3 repeatedly lists, "briefs" because it can be used for many types of assessment of individual student learning. The briefs allow rich assessment opportunities in most categories of significant learning, especially 1) learning to learn skills particularly evidence-based decision making,[13] and becoming a self-directed and self-regulated learner; 2) integrating and connecting different disciplines, perspectives, ideas or theories; 3) application/ problem solving, and critical thinking through the application of theoretical knowledge to make decisions about the particular patient in their problem; 4) acquiring various skills including information literacy[12], written communication skills and skills in using technology; and 5) mastery of knowledge. Rubrics can be used by students and faculty to efficiently assess students on each of these learning outcomes.

Assessment of information literacy skills used in briefs. More specifically, briefs can be used to assess students on several information literacy standards[12] including acquisition of information effectively and efficiently, critical evaluation of information and its sources, and the use of information legally and ethically.[8] Research documenting the abilities of students in other PBL programs can be applied as benchmarks for assessment. When students are required repeatedly to find their own resources to address their learning issues, they become aware of the most appropriate resources. They learn where to go for information and why different types of resources are helpful to answer different types of questions.[19] This occurs at the same time they are learning the content itself. Research shows that after several months in a PBL curriculum students learned that they should go to different types of resources depending on the type of question raised and overcome their temptation to Google everything. Students learned when it is appropriate to use textbooks and when they have to read primary or secondary sources. To be more specific, students knew that a comparison of the current incidence and prevalence rates of a disease among sub-populations in the United States required searching databases or government Websites. They knew when they needed to do a detailed review of the literature or reading review articles. They also learned that experts, either faculty members or practitioners in the field, and librarians can also be consulted on learning issues.[19,21] After one year of study in a PBL curriculum, graduate students in public health demonstrated an understanding of the principles of evidence-based decision making and applied these principles to their search for appropriate information resources.[19] These benchmark findings can become norms or standards for assessing individual performances against these norms.

Student portfolios or learning logs. Because briefs are written, they can become a cumulative record of the students' work throughout a semester, making it easy to demonstrate to the students their progress over time. Students can also be asked to develop a portfolio of their learning in each of the relevant categories of significant learning by selecting their best examples of briefs on specific learning outcomes such as their critical thinking, integration, or inquiry and analysis. Students can select the category that the brief illustrates, or faculty, through feedback, can help students to determine if a brief meets a specific learning outcome. Such a portfolio can be a cumulative record to show their development in each learning outcome category across semesters. A simpler version of this portfolio idea is for the students to keep a log of their satisfactory briefs by specific examples of learning outcomes and for the faculty to review this log to help students identify in what categories or specific outcomes they need to gain greater mastery.

Second iteration of the case discussion. While we can assess students on aspects of their knowledge on the first iteration, a more complete picture emerges when they reconvene to discuss the case again. We would expect a higher level of performance on all components of knowledge. Peers and the student him/herself can do personal assessment or assess others on their improvement and progress from the first iteration to the second on aspects of knowledge. Faculty assess the students at this point but some faculty members favor evaluations on knowledge from the second discussion over those on the first iteration because the students are more prepared on the topics. I have found that shy students more often contribute only when they think they have something of value to add. The second iteration of the case particularly allows for an assessment of conceptual knowledge and the acquisition of deep learning. All of these assessments of the different types of knowledge are derived from repeated observations of student performance while they are engaged in these steps.

DISCUSSION

As shown in Table 3, the entire PBL process offers many opportunities for assessment of different examples of all seven of Fink's[2] categories of significant learning. Aspects of motivation, the human dimension, integration, application, knowledge, and skills can be assessed throughout all of the group discussions of problems. Many of the examples given in this paper of embedded assessments are easy to conduct throughout the PBL process because of the way PBL is structured.[8] The students are demonstrating their learning in different categories as they progress through the steps of PBL problem discussions. Therefore, learning and assessment can be integrated without taking time away from learning. A further reason why embedded assessments are easy to conduct in PBL programs is that there is close interaction between faculty and students in small groups. Within the small groups, students can better observe their peers and are well-informed peer assessors.

These examples of assessments are consistent with the overarching goals of PBL programs, the objectives of the course and the teaching/learning activities. Gathering assessment data as suggested in this article results in an aligned PBL curriculum.[1] In addition to being a best educational practice, curriculum alignment is consistent with current accreditation mandates, such as LCME.[3] Fink's[2] classification method has been cited as a possible standard that accreditation agencies can accept.[7]

As Table 2 shows, peers are appropriate assessors for many of the examples of significant learning. Training students to do embedded, authentic assessments not only improves their ability to assess their peers but also is instructive in that it shows students the level of performance expected.[8] Feedback that is very specific and concrete is more helpful for promoting changes, and my experience shows that faculty can model how to give this kind of feedback. At first, students feel uncomfortable giving each other any thing but positive, even superficial feedback. When I give students an assessment form or specific evaluation criteria they often give more constructive feedback. Students can rank themselves and each of their peers orally or by using a written form listing specific criteria.

Students might even see a different perspective than the faculty members. For example, a student might always show respect publicly, but may be discourteous to a certain student member of the group such as a female or a minority student outside of class or perhaps in clinical situations. Students are aware of their peers who were especially helpful in critical thinking or integration or who assisted them to formulate better information searching strategies. Peer feedback is most useful in the context of formative assessment. Knowledge and skills may be the two areas where more expertise is needed to be able to be a valid assessor. Therefore, students should not assess their peers on these categories. Faculty members, of course, have the final authority in summative assessment.

This paper describes how faculty and administrators can develop an assessment system for PBL using a framework adapted from Fink's[2] learning categories. Explicitly stating approved college educational standards or accreditation guidelines as part of the rationale makes a more compelling argument for why these specific outcomes should be assessed. Using the framework presented in Table 2 educators can successfully resolve one of the fundamental issues in all forms of education, which is how to assess student learning. The assessments chosen from the framework lead to a system of assessing learning outcomes that can be aligned with the objectives and the teaching methods. Therefore, learning should be maximized and the assessments themselves should become further opportunities for learning and not taking away time from learning. Using this framework as shown in Table 2, educators may choose other examples of specific learning outcomes and other ways to assess them. More specifically, course directors can use this framework to decide which learning outcomes they want to assess and how to assess them.

Several of Fink's[2] categories of significant learning, including "learning how to learn" and "skills", foster self-initiated learning throughout the students professional lives. This paper describes how to assess students on specific examples of these categories, including using evidence-based decision making,[13] becoming a self-regulated, self-directed learner and information literacy skills.[12] All of these examples relate to aspects of self-initiated, lifelong learning. Assessment of summaries of material that students researched on their own from the medical literature can be especially useful for evaluating the development of self-initiated learning, a type of learning that should continue well beyond medical school.

CONCLUSIONS

It is essential that different outcomes be assessed at different times and that all outcomes are not assessed throughout, otherwise faculty and students can be overwhelmed with assessment forms. If students and faculty are always focusing on assessment, these activities can become ritualized and trivial. This framework can be used to develop a systematic and integrated plan for what learning outcomes will be assessed, and how and when they will be assessed in a PBL curriculum. Such a plan can help to make the assessments a meaningful learning experience. For example, pre-clinical program directors might decide to focus on a few specific learning outcomes at different points in a pre-clinical PBL curriculum or at different times in a semester. Through the use of this framework, faculty can decide how they will assess each learning outcome. Students, of course, should be informed what categories they are being assessed on and when.

One of the inherent dangers of this new emphasis on assessment is that such assessments can detract from the main purpose of education, i.e. learning. Using embedded assessments as much as possible can maximize the learning while also gathering assessment data. Such assessments do not isolate the evaluation phase and thus, do not take away time from learning. The primary role of faculty needs to remain a facilitator of student learning.

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Appendix A An assessment of professional behaviors (Maritz[15])

Name: ______________________________ Date:_________

Professional Behaviours

1. Interacts effectively with patients, families, colleagues, other health care professionals, and the community

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

2. Able to self-assess, self-correct and self-direct learning

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

3. Communicates effectively (speaking, body language, reading, writing, listening) for varied audiences and purposes

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

4. Able to recognize and define problems, analyze data, develop and implement solutions and evaluate outcomes

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

5. Able to identify sources of and seek out feedback

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

6. Able to effectively use and provide feedback for improving personal interaction

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

7. Able to question logically

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

8. Able to recognize and differentiate facts, illusions, assumptions, and hidden assumptions

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

9. Able to distinguish relevant from irrelevant

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

10. Able to exhibit appropriate professional conduct

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

11. Able to identify sources of stress and develop effective coping behaviors

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

12. Demonstrates a positive attitude in the clinic

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

13. Demonstrates flexibility in the clinic

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

14. Able to work well with others in the clinic

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

15. Adheres to ethical standards

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

16. Demonstrates integrity, honesty, and respect for others

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

17. Able to focus on tasks at hand

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

18. Able to receive feedback in a non-threatened manner

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Always

(Adapted from May [22])

COMMENTARY

How Can I Improve My Feedback to Learners?

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Feedback is an essential component of teaching, providing information about performance, with an emphasis on the aspects, which were done well, and those needing change or improvement. In this way, feedback helps to reinforce learning, and completes the learning cycle. One of the principles of adult learning is that adults require regular feedback. Ende[1] defines feedback as an "informed, non-evaluative, objective appraisal of performance in a given activity, in order to guide performance in the same or related activity." Learners, be they students, residents or practicing physicians, need to be provided with an ongoing and specific critique of personal performance – their strengths as well as the areas needing improvement. Providing effective and valid feedback to learners is an essential skill for teachers, as their learners need to be aware of what they are doing well and need guidance on what needs to improve or change. It is an essential formative part of a medical student or resident's education. This commentary aims at providing a guide to faculty for providing effective feedback to their learners with regard to their achievement of learning goals.

What is the difference between feedback and evaluation?
Feedback differs from evaluation in that feedback is given in a situation with no grading, the objective being to improve students' performance. Feedback is formative assessment, allowing students and teachers to adjust learning and teaching strategies. There is a dialogue between the student and the teacher as to what the criteria and standards are for successful or unsuccessful performance. Feedback supports a developmental approach to achievement.

Evaluation is summative and provides quality assurance. It is based on past performance and has grading consequences.

Learners' and teachers' perspectives on feedback
Medical students and residents report that feedback does not occur often enough[2,3] whereas faculty believe they are providing adequate feedback[4]. A recent study states that while faculty and students reported similar amounts of time that were devoted to feedback, faculty reported more items included than did students, and there was poor agreement between the content of the feedback reported by the two groups [5].

Different techniques have been used to increase feedback in clinical situations; including feedback prescription pads and encounter cards. In a recent study, students solicited one faculty and one resident every 2 weeks for written feedback on a "feedback prescription pad"[6]. Each prescription requested four comments: two things the student did well and two things the student needed to improve on. Students rated feedback using a five-point scale. Students' rating of feedback improved significantly, although the overall quality of feedback was found to be poor. Only 10% of comments were found to be specific enough to be useful to the students.

Paukert and coworkers used encounter cards in a surgery clerkship to increase the feedback received from faculty, fellows, and residents[7]. Encounter cards are pocket-sized cards with the chief focus of encounter, and the eight domains of clinical competence identified for evaluation. Students were asked to present their cards to an evaluator before a clinical encounter, and the evaluator rated the students' performance on one of the domains, checked off the appropriate global rating, and gave verbal or written feedback to the student. Implementation of the encounter card system increased student satisfaction with the feedback process.

With regard to methods of delivery, Elnicki et al.[8] found that there were no differences in perception by residents as to whether oral or written feedback was provided by their faculty about their continuity clinic performance. Schum et al.[9] found that the use of feedback notes to medical students and residents led to more feedback, which was both specific and received favorable reviews from both faculty and trainees.

For faculty to provide useful feedback, certain preconditions need to be construed as necessary[10,11]. The first is setting the "climate" or "tone", as learners are most receptive to feedback when provided by faculty who they believe have their interests at heart. Thus, a climate of trust between the learner and the teacher is essential. Another pre-condition is orientating learners to feedback, informing them of when and how feedback will be given. In this way, feedback will not come as a surprise to the learner. The third is arranging to conduct feedback sessions in a setting, which is conducive to learning.

What is valid and effective feedback? It is an objective description of a learner's performance and is based on accurate observations by the faculty member. Branch and Paranpaje stated that there are three general categories of feedback[12]: These categories include:

1. *Brief* feedback, in which the teacher makes very specific and concrete suggestions based on a recently observed performance,
2. *Formal* feedback, in which time is designated for the faculty member to provide feedback to the student. The setting and the time available should be appropriate and conducive to the feedback that will be given, and
3. *Major* feedback in which feedback is scheduled as part of the curriculum – such as at the midpoint of a course or clinical rotation – within a designated time period and covering specific topics.

How then can I, as a faculty member, improve my feedback to learners?

Certain principles for providing feedback are described in the literature.[1,8, 9, 13, 14] These include:

1. State clearly the goals and objectives of the learning experience. These should be disseminated, understood, and supported by faculty and learners. If possible, delineate the standards of performance for each objective so that both learners and faculty recognize the level of expectation and can measure performance in an objective manner.
2. Request the learner's self-assessment of performance. Inviting the learners' self-assessment not only helps to foster a collaborative relationship between teachers and students but also encourages professional independence and life-long learning practices.
3. Link feedback to the instructional goals and objectives. Only then will the learner be able to determine what has been accomplished and what remains to be achieved within the framework of learning. The learners need to know what they have achieved or have yet to achieve in progress towards a goal.
4. Provide feedback in a timely manner. By providing feedback promptly, and as close to the event as possible, the learner can recall what she/ he did or thought at that time and the rationale for an action. The reasoning that the learner used to problem-solve in the basic sciences or the fears, discomforts, feelings and uncertainties in the clinical encounter; other strategies which had been considered; and the knowledge applied; can still be recalled, prompting the learner to modify behavior or interpretation of a situation. If feedback is too late for learners to change their performance, then it will not be useful.
5. Provide specific feedback. Learners need to know exactly what was effective and what was not. Generalities do not help the learner to change or understand what they did: what action was ineffective or effective and why.
6. Link feedback to behaviors that can be changed. It is not useful for the learner to receive feedback on something that cannot be changed. Giving personal judgments such as "You are arrogant" or "You are clumsy" are not changeable behaviors for the learner. Statements about worth or potential may be embarrassing or humiliating to the learner.
7. Make objective statements based on observation. Accurate observations are essential in providing valid and effective feedback. They will allow faculty to provide objective evidence of what the learner said or did. Providing examples and rationale are useful for learners to change their behavior.
8. Tell the learner what she/he did well. This encourages the learner to continue doing these specific things in the future. It also helps to make the learner feel safe and secure. Do not qualify the positive feedback with a negative statement such as "BUT…..or HOWEVER…."
9. Limit constructive feedback to three items or less at a time. It is tempting to tell the learner all the issues that need to be improved upon. However, it is very important not to overload the learner with information. By limiting information to a few items, the student will be able to focus and reflect on these items.
10. Check that the student understands your feedback; whether it was seen as fair and accurate; and develop with the learner a plan for improvement.

In summary, feedback is about students learning to self-evaluate, helping them to take greater ownership of their learning, thereby increasing the likelihood that they will come to direct their own learning. Providing feedback is thus an essential component in medical education and the basic principles and techniques for delivering feedback have a vital application in teaching. These principles are important for faculty development as many faculty have difficulty in providing feedback to their learners and this guide could be of use to them. As one of the goals of medical education is to foster medical students and residents to be active, lifelong, self-directed learners, the more effective the faculty feedback, the better will this goal be achieved.

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Annex 1: *Some examples of giving feedback in the basic and clinical sciences:*

As a faculty member in the basic sciences:

(1) Take some time during the session to have students self-reflect or reflect collaboratively on what they have learned, their strengths and challenges, and what areas they have difficulty with. If there is not enough time during the session, this can be done on-line as a threaded discussion.

(2) Based on their self-reflection, provide feedback focused on their self-assessment - on what they have learned, ideas for improving their learning, what they will need to learn, and what strategies would work best for them. This will encourage them to take more responsibility for their learning.

(3) Monitor whether students incorporate the feedback that you have given in their ongoing activities.

(4) Give students an opportunity to try again, so that you can check whether they were able to improve on their learning.

(5) When using problem-solving multiple choice questions (MCQs), provide feedback in the form of explanations for both correct and incorrect answers – sometimes the student may have arrived at the right answer by chance or through incorrect reasoning.

As a faculty member in the clinical sciences:

Using Pangaro's [15] construct of R-I-M-E, to identify learner competencies as he/she moves from medical student to resident. The following are some examples of feedback: (RIME stands for *Reporter, Interpreter, Manager, Educator).*

Student/Resident as **R**eporter

" In taking Mrs. Jones' history, you asked her about nausea, vomiting, and prodromal malaise and fatigue. You did not ask her about pruritus or arthralgia? How might that help you in your differential diagnosis?

Student/Resident as **I**nterpreter

"From your history and physical examination of this patient with chest pain, you have come up with the most likely diagnosis, and I agree with you. What are the other differentials that you must consider, and what investigations would you do to rule them out, so that you do not have premature closure.

Student/Resident as **M**anager

You presented two patients with chest pain, having possible fractures of the ribs. Your report is succinct and accurate. How would you manage these two patients, as one of them is a 20-year old, and the other is 70 years old?

Student/Resident as **E**ducator

You have explained to the diabetic patient about what foods he should be eating, and his daily exercise regimen. You did an excellent job by checking with the patient whether he understood what you had told him, by asking what he would be telling his wife about his diet and exercise.

COMMENTARY

Randomization Made Easy for Small Size Controlled Clinical Trials

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ABSTRACT

The aim of randomization in clinical trials is the creation of groups that are comparable for any known or unknown, potentially confounding variables. Randomization, if done properly, ensures strengthening both the internal validity by minimizing selection bias and external validity by providing a correct basis for generalization. Randomization is a prime assumption to be fulfilled before the application of inferential statistics. Randomization in clinical trials generally refers to random allocation of subjects to treatment groups. Simple randomization, block randomization, stratified randomization, and minimization methods are discussed in this article.

INTRODUCTION

A researcher is mostly interested in what will happen rather than what has happened. How a treatment works in a larger population is of more concern than its effect in a small group of cases. In clinical trials the aim of the study usually is to predict the efficacy or effectiveness of a treatment for masses. Certain assumptions are required to be satisfied for drawing inference about the population by studying a sample of that population. One of the important assumptions is randomization. The primary objective of randomization is to ensure that all other factors that may influence the outcome be equally represented in the two groups, with the only dissimilarity then being the treatment under trial, so that any difference in outcome can then be regarded as the treatment effect. A number of inclusion-exclusion criteria and prognostic constraints in clinical trials restrict selecting a sample randomly from the population. The most usual way is to screen cases and register those who meet the required criteria, and then from the common pool allocate subjects randomly to two groups namely, the control group and the trial group. This is referred to as randomly allocated samples rather than random samples. Random allocation means that each subject has a known chance, usually an equal chance, of being given each treatment, but the treatment to be given cannot be predicted.

Randomization minimizes selection bias by unbiased allocation of treatment to comparison groups and thereby improves the internal validity in controlled clinical trials.[1] Randomization being a requirement for the application of inferential statistics, if conducted properly may ensure adequate external validity or generalizability. The CONSORT (Consolidated Standards of Reporting Trials) statement intended for improving the reporting of a randomized control trial, enabling readers to understand a trial's conduct and to assess the validity of its results, has given much emphasis on randomization. The CONSORT statement includes a 22-item checklist and a flow diagram.[2] The items numbered 8, 9 and 10 are on randomization (Item-8: Randomization - sequence generation; Item-9: Randomization - allocation concealment; Item-10: Randomization - implementation).

There can be many methods of randomization: for instance, random number table, coin tossing, the chit method, and computer and randomization programs now freely available on the Internet. In spite of all efforts, some researchers conduct inappropriate randomization and report results inadequately. The aim of this article is to elaborate step-by-step some simple methods of randomization for random

Table 1. Chit Method for Randomization

Draw	1st				2nd				3rd				---	13th	
Result (Letters on chit)	C	T	C	T	T	C	C	T	C	C	T	T	---	T	C
Registered Case (No. (Allocation)	1	2	3	4	5	6	7	8	9	10	11	12		49	50

allocation of subjects to two groups of preferably equal size in clinical trials.

Simple Randomization

An easy way of randomization is coin tossing. Once a subject, after screening, is registered for trial, a coin may be tossed for deciding the allocation to group (control or trial). However, if size of the groups is required to be equal, this method may prove to be unfit, especially in smaller studies. In a large number of draws the number of heads and tails are more or less equal, but when a coin is tossed for smaller number of times (say) 50, it may result in 30 heads and 20 tails leading to unequal size of groups with 30 cases in one group and 20 in other group. So, this method may yield an unequal division between the groups not only at the end of draws but also at any time during the draws.

In such a situation, a better way may be to generate a random allocation sequence. A random allocation sequence may be generated before registration of cases for trial. If a study requires (say) 50 cases for a clinical trial of a treatment to be randomly allocated equally into (say) control and trial groups, various methods can be used to achieve this scenario. A simple method of generating random sequence may be the chit method. For random allocation of 50 cases into two groups equally, prepare 50 chits writing "C" (for control group) on 25 chits and "T" (for trial group) on 25 chits. After folding the chits and putting in a box and well mixing, draw a chit, note the letter written on it, and then draw the second chit without replacing the first, note it and proceed similarly until the last i.e. 50th chit is drawn. The generated random allocation sequence may be one as appears in Table 1.

According to this sequence the first case registered will go to the control group, second case again to the control group, the third to the trial group and so on to the last case to control group. The method yields equal allocation of cases to both control and trial groups (25 each) by the end of the last draw. However, at any time during the draws, the number may remain unequal between the groups, as can be seen above where, after the fourth draw there will be three cases in the control group and one case in the trial group. The method also suffers the loss incurred by drawing without replacement. A possible alternative is the block randomization method.

Block Randomization

In simple randomization, the number of cases allocated to the control group and the trial group will probably differ at any point in the sequence. To keep the numbers in each group very close at all times, block randomization also called restricted randomization is used.[3] For a block of (say) four cells there are only six ways in which two cells get treatment "C" (control) and two get "T" (trial). Blocks can be chosen at random to create the allocation sequence. More elaborately, when a coin is tossed 4 times there can be 16 possible outcomes, of which 6 outcomes will have exactly 2 heads (H) and 2 tails (T) as follows: 1. HHTT, 2. TTHH, 3. HTHT, 4. THTH , 5. THHT, 6. HTTH.

For convenience, "C" for control may replace "H" for head and "T" for tail may now mean "T" for trial. Now, six chits may be prepared by writing CCTT on chit-1, TTCC on chit-2 and so on until you reach CTTC on chit-6. After folding the chits properly and mixing well in a box, the chits are drawn, but with replacement (a chit drawn is replaced in the box before next draw).

In the order of draws the letters on a chit are noted and in the same order as written on the chit. To allocate 50 cases randomly to the control group and the trial group by this method a sequence of choice may appear as given in Table 2.

It is to be noted here that after the 12th draw the number reaches 48 with equal allocation of C's and T's (24 each) and the next draw will cross 50 by 2 more numbers. In this case, only two letters are needed for the 13th draw and those two should not be same. A possible way may be to remove two chits bearing letters CCTT and TTCC from the box before the last, i.e. 13th draw. Then draw one chit and note

Table 2. Block Randomization

Draw	1st	2nd	3rd	4th	5th	6th	7th	--	--	--	49th	50th
Result	C	C	T	C	T	T	C	--	--	--	T	C
Registered Case No.	1	2	3	4	5	6	7	--	--	--	49	50

only the first two letters which may be "CT" or "TC". Whenever, the sample size (n) needed is a multiple of four like 24, 40, 48, 52, 60, then by drawing with replacement 6, 10, 12, 13, 15 chits, respectively, result in a random allocation of cases into two groups of equal size. Otherwise, when n is even (needed for equal division) but not a multiple of four like 22, 46, 54, 70 etc., the procedure as given in case of 50 may be adopted.

Thus, by this method numbers in the two groups at any time cannot differ by more than half the block length. Usually block size is a multiple of the number of treatments under study. Small blocks should always be preferred as they control balance better. The procedures given here may also fit well when it is not necessary to maintain equality between group sizes as can happen when the total sample size (n) is odd.

Simple and block randomization may eliminate bias from the allocation process but cannot ensure similarity on certain characteristics of cases in each group. Similarity may be achieved through stratified randomization.

Stratified Randomization

Randomized block design commonly referred to in clinical trial as "stratified randomization" can be used to ensure balance between groups of patient characteristics. For example, in a controlled trial to study the effect of amiodarone in the management of arrhythmia, occurring after a coronary artery bypass grafting operation, if a researcher intending to balance the groups between diabetic and non-diabetic patients uses block randomization, which creates groups equal in size, he may find the control group accumulated with a large proportion of diabetic patients compared to the trial (amiodarone) group. Now, if the amiodarone group showed significant improvement, it may be argued that the presence of a large number of diabetic patients in the control group, who might have responded slowly and would thereby have lowered the mean, would make the difference significant.

Stratified randomization suitable for such a situation, consists in dividing the cases registered for study into strata (as diabetic and non-diabetic in this example) and generating separate random allocation sequences by simple or block randomization for each stratum. The block randomization method instead of simple randomization should always be preferred within each stratum to ensure control of balance of treatments within strata. Stratified randomization may be extended to two or more stratifying variables. In the above example, if age is taken as another prognostic factor then with two categories (say) ≤ 50 years and >50 years, there will be 2 x 2 = 4 strata i.e., (1) diabetic with age ≤ 50 (2) diabetic with age >50, (3) non-diabetic with age ≤ 50, (4) non-diabetic with age >50. So, here four separate random allocation sequences are required to be generated for allocating cases to the trial and control groups. Thus, if a patient registered is diabetic with age greater than 50 years, then he will go to Strata-2 and will be allocated to the control group or trial group as per list generated for Strata-2.

It needs to be mentioned that in small studies it may not be practical to stratify on more than one or two variables, because simultaneous stratification for several prognostic factors can lead to more number of randomization lists than the number of participants in the study. In order to achieve close similarity between groups for several variables, minimization may be more practical alternative.

Minimization

Stratified randomization with block randomization within each stratum can be the preferred method to ensure balance between groups in size and subject characteristics. However, stratified randomization using several factors in small trials may become impractical. The minimization method may prove to be an alternative approach in such situation. Minimization consists in minimizing the total imbalance across all factors rather than any one factor. In this method, the first participant is allocated randomly to a treatment group then each subsequent participant is allocated after determining which group would lead to a better balance between the groups with respect to the variables of interest.[4] For example, suppose three factors (say) "A", "B" and "C" are required to be balanced between trial group and control group in a study. Assume factor-A has three categories "a_1", "a_2" and "a_3"; factor-B has two categories "b_1" and "b_2" and

Table 3. Minimization Method

Prognostic Factor (Stratifying variable)	Category of the factor	Trial Group (Size = 10, after 20th allocation)	Control Group (Size = 10, after 20th allocation)
A	a_1	4	2
	a_2	3	4
	a_3	3	4
B	b_1	4	6
	b_2	6	4
C	c_1	2	3
	c_2	5	5
	c_3	3	2

factor-C has three categories "c_1", "c_2" and "c_3". Let the first (say) twenty cases under study be randomly distributed equally in the trial group and the control group, showing the distribution of characteristics as displayed in Table 3.

If the next (i.e. 21st) subject has characteristics (say) "a_1", "b_2", "c_1" then adding the existing frequencies of "a_1", "b_2" and "c_1" for each group shows the following imbalance,
Trial Group: 4 + 6 + 2 = 12
Control Group: 2 + 4 + 3 = 9

So, the allocation of the 21st subject to the trial group would make the total 15 for the trial group and thereby increase the imbalance. Whereas, allocation of the 21st subject to the control group would make the total 12 for the control group and thereby decrease the imbalance (equalize in this case). If at any time the total of the trial group and the control group is the same, then allocation by simple randomization may be the method of choice.

It is worth mentioning here that minimization may be viewed parallel to stratified randomization, but since it lacks proper randomization, it may not always prove to be equivalent to stratified randomization.[5] A debate on its acceptability is continuing with greater resistance from explanatory trialists.

Lastly, randomization is primarily needed for eliminating selection bias but to achieve the benefits of randomization, the concealment of generated random allocation sequences should always be ensured. Randomization coupled with concealment may only ensure elimination of selection bias.

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Nutrition and Wellness: A Personalized Educational Exercise for Medical Students

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ABSTRACT

Whereas many patients look to their physicians for nutritional advice, few physicians believe they are adequately prepared to provide such information. Over half of graduating medical students describe the time devoted to nutrition in medical school as inadequate. This study examined the effects of an innovative and personalized approach to medical student nutrition education on students' willingness to discuss nutritional issues with their patients and their intent to change personal health-related behavior. The study also assessed medical student sources for nutritional information. Second-year medical students participated in a nutritional exercise that consisted of receiving their own lipid panel, fasting plasma glucose, and arterial pressure measurements, selecting a healthy lunch from a fast food menu, and discussing nutrition with a clinical dietician. Students then completed a nutrition awareness survey. Over 90% of students reported that they were likely to counsel patients on nutritional issues or refer them to a dietician. Forty-six percent stated that the exercise would result in a change in their own diet or exercise pattern; only eighteen percent anticipated changing their reliance on health care practioners. The majority of students felt they were knowledgeable about nutritional guidelines. However, this knowledge came chiefly from self-directed learning or mainstream media rather than from medical school instruction or health care professionals. The results suggest that the personalized nutrition exercise had a positive effect on student attitudes toward the role of nutrition in medical practice and confirm the need for improved delivery of nutrition education in the medical curriculum.

INTRODUCTION

Many health problems in the U.S. are attributable to improper diet. In fact, dietary factors are associated with 4 of the 10 leading causes of death in the United States including coronary artery disease, certain types of cancer, stroke, and type 2 diabetes.[1] In 2000, poor diet and physical inactivity were linked to 400,000 deaths in the United States.[2] The Canadian Task Force on the Periodic Health Examination[3] recommended that physicians provide general dietary advice to all patients. Other organizations including the American College of Preventive Medicine, the American Academy of Family Physicians, the American Academy of Pediatrics, and the American College of Obstetricians and Gynecologists advise physicians to provide nutritional or dietary counseling for patients at risk for chronic disease.[4]
Unfortunately, many physicians fail to provide nutritional advice to their patients. Direct observations of family physicians found that nutrition counseling occurred in only 24% of all patient visits. This improved slightly for patients with diabetes (45%), cardiovascular disease (25%), hypertension (31%), prenatal visits (26%), and obesity (33%). Of all physicians monitored, only 6% included nutrition counseling in the majority of patient encounters. Even when nutritional counseling occurs, it is most likely superficial, averaging 55 seconds.[5]

Although time constraints may be responsible for some of this failure, many physicians do not feel they have adequate expertise to provide nutritional counseling to their patients. On average, 63% of physicians reported inadequate training in the area of nutrition counseling for patients with chronic illnesses.[6]

Medical schools play a major role in physician education and practice and, thus, influence greatly practitioners' knowledge, skills, and subsequent behaviors with their patients. Despite requests to enhance the nutritional education provided within medical education curricula, schools continue to struggle to provide recommended training in this area.[7,8] For example, a 1985 National Academy of Sciences[9] comprehensive survey of medical schools found that nutrition education was "inadequate." A more recent study found that only 41% of medical schools surveyed provided what is considered to be minimal nutrition education based on the National Academy of Sciences recommendations, whereas less than 20% met the more rigid standards set by the American Society for Clinical Nutrition.[7] These concerns are echoed by graduating medical students. According to the 2005 Association of American Medical Colleges Graduation Questionnaire, over 51% of students rate the time devoted to nutritional instruction within medical school as "Inadequate." [10]

Several authors have identified components of successful education on this issue. Recommendations include the development of innovative strategies that involve the student directly in the nutritional learning process[11] along with those that stress a personalized approach.[12] It is believed that the incorporation of these components will not only lead to greater knowledge regarding nutrition, but also to increased nutritional counseling efforts directed toward patients. Martin, Watkins, and Ramsey[13] developed a medical physiology laboratory to help students learn to evaluate and discuss nutritional status and principles of dietary planning. Their laboratory exercise included measurement of a lipid panel on each student and use of dietary guidelines to order a nutritionally balanced meal. When we decided to modify this exercise for use in a nutrition unit in the second year medical curriculum at Creighton University, we wondered whether an additional benefit would be a change in student attitudes toward the role of nutrition in their own lives and in their approach to medical practice.

Therefore the present study examined the impact of a personalized approach to medical student nutrition education. The principal aim was to determine the effectiveness of this educational approach in influencing students' willingness to include nutrition education in their approach to health care. Closely related was the second aim, to assess the effectiveness of the nutrition exercise in influencing students' personal behavior. The third aim was to assess medical student sources for nutritional information. The final aim was to provide students information about the professional roles and responsibilities of clinical dieticians.

MATERIALS AND METHODS

As part of the nutrition education exercise in a required, integrated basic science course, second-year medical students (n = 117) were asked to predict their own results on common indicators of nutritional status: a plasma lipid panel (total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides), fasting plasma glucose, and arterial pressure measurement. Students recorded their predictions and calculated their body mass index on a work sheet that they retained. The students were asked to postpone eating from midnight until an early morning finger stick blood sample was drawn (a free breakfast was available following the finger stick). The lipid panel and fasting glucose were analyzed on the spot by a Cholestech LDX (Cholestech Corporation, Hayward, CA) and results were returned directly to the student. Systolic and diastolic arterial pressures were measured by auscultation.

Students used a Wendy's restaurant menu and a U.S. Nutrition Information chart provided by the restaurant to order a healthy lunch. Appropriateness of the menu selection was based on calculated body mass index and the student's own estimate of activity level according to dietary guidelines for calories and saturated fat provided by registered dieticians who participated in the activity. The dieticians recommended that daily energy intake be limited to 20 kcal/kg for weight loss, 25 kcal/kg for weight maintenance with normal activity, and 30 kcal/kg for physically active individuals. Lunch was limited to one-third of daily calories of which no more than 10% could be derived from saturated fat. Lunch orders were screened for conformity with the guidelines and then filled by a local Wendy's restaurant. Groups of 15 students ate lunch with one of the participating dieticians, who discussed nutritional information, healthy diet and lifestyle, and patient education.

Following this lunch meeting, students were asked to complete a Nutrition Awareness Survey. This survey asked students to self-assess: 1) knowledge of nutritional guidelines, 2) their own diets, 3) their own sources of nutritional information, 4) the impact of the nutrition exercise on their dietary choices, and 5) the impact of the exercise on the likelihood of their including nutritional information in discussions with patients. The survey also asked students to quantitatively report the discrepancy between their predicted and actual lipid panel, fasting glucose, and blood pressure measurements; they were not asked for actual measurements.

We characterized the student under- or overestimation of the results of the nutritional indicator measurements using the standard deviations of the published measurements of fasting blood lipid and glucose levels in a similar group of medical students.[13] We characterized a discrepancy greater than one standard deviation as a *major discrepancy*, and a discrepancy of 0.5 – 1.0 standard deviations as a *minor discrepancy*.

Data Analysis

Seventy Nutrition Awareness Surveys were returned. Data were entered into SPSS for analysis. Three students' self-assessments for the nutritional indicator discrepancies appeared too large to be discrepancies and looked instead like actual values. Therefore, they were excluded from analyses. Using a standard statistical package (SPSS version 14.0) data were first analyzed by calculating descriptive statistics. Pearson correlations were used to characterize associations between students' self-assessments and statements regarding their intention to change diet and exercise. Independent sample t-tests were used to investigate differences between subgroups. An alpha level of .05 was used for all statistical tests. Students were also asked to complete an online survey about the lunch meeting with the dieticians. Twenty-three students submitted the evaluation; results were analyzed using WebSurveyor.

Participation was voluntary and the confidentiality of the information collected during the study was guaranteed. The university's Institutional Review Board reviewed the research protocol and survey questionnaire and granted the study exempt status.

RESULTS

Of the 117 nutrition awareness surveys distributed, 70 were returned. Thirty-eight respondents were female (54%), 28 were male (40%), and four (6%) did not indicate gender. This overall course enrollment was 54 (46%) females and 63 (54%) males. Although females were overrepresented among the responding students, we found no statistical differences in the responses of the males and females. The results described here include: 1) effects of the nutrition exercise on student willingness to include nutrition in their approach to health care, 2) effects of the nutrition exercise on student personal decisions to contemplate a change in their own behavior, 3) sources of information about nutritional guidelines, and 4) evaluation of the lunch session with clinical dieticians.

Almost all the students reported that the nutrition exercise made them more likely to discuss nutritional information with patients, recommend behavioral changes to their patients, or refer patients to a dietician (Table 1).

After learning their lipid panel results, about half of the students reported contemplating a change in diet and exercise (Table 2). Far fewer (18%) reported contemplating increased use of health practitioners to monitor cardiovascular risk factors. There was no statistically significant difference between the male and female respondents in willingness to contemplate lifestyle changes.

To obtain some insight into the factors that influenced whether the lipid panel results would produce a change in a student's attitudes, we asked students whether they considered their diet "healthy." Few students (17%) felt their diet was not healthy and most (70%) were comfortable with their knowledge of nutritional guidelines (Table 3). Not surprisingly, there was a significant negative correlation between student self-assessment of healthy diet and contemplation of a change in both diet ($r = -.45$, $p < 0.05$) and exercise ($r = -.38$, $p < 0.05$). There was no correlation between student self-assessment of nutritional knowledge and contemplation of change in diet or exercise.

We also asked the students to report how accurately they had predicted their arterial pressure (systolic/diastolic) and the results of the lipid panel and fasting plasma glucose measurements. To reassure the students of the confidentiality of their personal data, we did not ask them to report the actual values. Fewer than half the students accurately estimated their blood lipids (Table 4); there was no statistically detectable difference between the number of "overly healthy" and "overly unhealthy" estimations. Arterial pressure predictions were more accurate, probably reflecting the likelihood that the students had measured their arterial pressure recently.

We asked each student to review a list of sources of information about nutrition and indicate which was their primary and which their secondary source. Students could also list other sources. The most common primary and secondary sources were *Self-Directed Education* and *Mainstream Media*, respectively (Table 5). *Medical School Coursework* was fourth on the primary and third on the secondary lists. Physicians or other Healthcare Providers were listed by only 8% of the respondents as either a primary or secondary source.

Table 1. Impact of the nutrition exercise on future patient care

After completing this activity, how likely are you to:	Very Likely	Likely	Neutral	Unlikely	Very Unlikely	Mean†
…discuss nutritional information with patients?	25(36)*	40(58)	4(6)	0(0)	0(0)	4.30
…refer patients to a dietician?	25(36)	40(58)	4(6)	0(0)	0(0)	4.30
…recommend behavioral changes to patients?	39(57)	28(41)	2(3)	0(0)	0(0)	4.54

* Data are Number of Students (% of all Respondents); † mean response on Likert scale of 1 (very unlikely) to 5 (very likely).

Table 2. Impact of lipid panel results on lifestyle choices

The results of my lipid panel will lead me to contemplate a change in my…	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean†
…diet.	6(9)*	25(37)	19(28)	14(21)	4(6)	3.22
…exercise.	6(9)	25(37)	18(27)	14(21)	5(7)	3.19
…use of health practitioners to monitor cardiovascular risk factors.	1(2)	11(16)	21(31)	25(37)	9(13)	2.55

* Data are Number of Students (% of all Respondents); † mean response on Likert scale of 1 (strongly disagree) to 5 (strongly agree).

As part of the overall course evaluation, approximately two weeks after the nutrition exercise, students were invited to complete a brief, online evaluation of the lunch meeting with the dieticians. The response, albeit from a limited number of participants (n=23), was positive. Students felt that "The lunch time small group was well designed and organized" (Mean 4.26/5, SD .75); "I enjoyed this learning experience" (Mean 4.17/5, SD .98); and "The dietician was effective in communicating nutritional guidelines" (Mean 4.43/5, SD .59).

DISCUSSION

The nutrition exercise offered an innovative and personalized approach to engage students to learn about nutrition. The most significant outcome of the exercise was the effect on students' plans to discuss nutritional information and related topics with their patients. Over 90% of the students responded that *after* completing the activity, they were very likely or likely to discuss nutritional information with patients and refer patients to a dietician. Almost all reported they were very likely or likely to recommend behavioral changes to patients. Because we could only ask students about their *intent* to change personal behavior or clinical practice we cannot assess whether students will actually engage in these efforts. Furthermore, we did not survey student attitudes before the nutritional exercise, so we cannot estimate the magnitude of the changes in student attitudes.

An important feature of the nutrition exercise was that it provided students with a personally relevant learning experience. This attribute has been identified in previous studies as essential to successful educational outcomes.[11,12] After completing the exercise, 46% of students agreed that the results of the lipid panel would lead them to contemplate a change in diet and exercise. As expected, there was a strong negative correlation between agreeing with the statement "I feel that my diet is healthy" and contemplation of change in diet and exercise: the students who are contemplating change in lifestyle are those who feel their current diet is not healthy. Because we did not ask students to submit their actual blood lipid and glucose values, our data do not address the accuracy of the student self-assessment of their diet. However, it was surprising that there was little relationship between the self-reported error in predicting LDL cholesterol and plasma glucose and the student self-assessment of their diet. Students who overestimated the quality of their nutritional status (as reflected in the blood lipid and glucose measurements) were as likely to indicate that they had a healthy diet as were those who underestimated their nutritional status.

Table 3. Self-assessment of diet and nutritional knowledge

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean †
I feel that my diet is healthy.	5(7)*	33(47)	20(29)	10(14)	2(3)	3.41
I am knowledgeable about nutritional guidelines.	12(17)	37(53)	12(17)	8(11)	1(1)	3.73

* Data are Number of Students (% of all Respondents); † mean response on Likert scale of 1 (strongly disagree) to 5 (strongly agree).

Table 4. Accuracy of lipid panel predictions

Test	Large Underestimate (-1 SD† mg/dl)	Minor Underestimate (-1/2 SD mg/dl)	Accurate (<1/2 SD mg/dl)	Minor Overestimate (+1/2 SD mg/dl)	Large Overestimate (+1 SD mg/dl)
	Discrepancy				
Total Cholesterol	16(24)*	8(12)	29(43)	7(10)	8(12)
LDL Cholesterol	10(15)	12(18)	28(42)	4(6)	12(18)
HDL Cholesterol	24(36)	9(13)	17(25)	4(6)	13(19)
Triglycerides	20(30)	10(15)	21(31)	6(9)	10(15)
Glucose	15(22)	11(16)	18(27)	8(12)	15(22)
	Large Underestimate (+ 10 mm/Hg)		Accurate (<10 mm/Hg)		Large Overestimate (-10 mm/Hg)
Systolic Arterial Pressure	9(14)		45(71)		9(14)
Diastolic Arterial Pressure	15(24)		39(63)		8(13)

* Data are Number of Students (% of all Respondents). † SD: standard deviation of fasting blood lipid and glucose levels in a group of first year medical students[13].

The lab value prediction exercise revealed that at best, only 43% of students predicted accurately their blood lipid values. Since the students were familiar with normal blood lipid and glucose values from their coursework, the discrepancy is probably not due to ignorance of the normal range. Rather, the discrepancy may reflect that most students had probably never had their blood lipid and glucose measured, as these measurements are not routine in health care practice. We had hypothesized that students would tend to predict their own health status to be healthier than the actual values. Therefore we were surprised that almost as many students' actual values were healthier than they had predicted, suggesting that they simply had little information about their nutritional status.

The survey of sources of information about nutritional guidelines indicates students look to venues beyond medical education such as the mainstream media and self-study. More than half of the students reported they considered self-directed education about nutrition a primary or secondary source, and nearly half cited the mainstream media as a primary or secondary source. The positive implications of self-directed learning notwithstanding, there may be concerns about the quality of the information students receive from the media and other sources they consult, especially in light of medical educational emphasis on evidence-based medicine. Medical school coursework was ranked below sources of information available to the general public, reflecting what we already suspected about the inadequacy of the nutritional content of our basic science curriculum (indeed, the exercise was part of our efforts to remedy this). However, the evidence suggests that this situation is not unique to our curriculum. Data from the 2005 AAMC Graduation Questionnaire[10] indicate that our graduates' assessment of the adequacy of their nutritional education is only slightly greater than the national average for medical schools. The small number of students who relied on physicians or healthcare providers for nutritional information suggests that health care providers do not serve as an important source of information on diet and exercise.

Finally, this exercise afforded an opportunity for students to meet with clinical dieticians and learn more about their professional roles and contribution to health care. Students rated positively the lunch sessions with the dieticians and, in particular, the effectiveness of the dieticians in communicating the nutritional guidelines. This exercise contributed positively to our students' perception of the usefulness of dieticians with 94% being likely to refer their own patients to a dietician for nutritional counseling. These findings highlight the potential advantages of interprofessional education efforts within the health sciences.

CONCLUSIONS

This nutrition exercise was a worthwhile and innovative addition to the second-year medical school curriculum that promoted active learning. The customized learning experience impacted the likelihood that our students will include nutritional education of their patients in their future practice. It also acquainted the students with the clinical

Table 5. Sources of nutritional information

	N(%)*
Primary	
Self-directed education about nutrition	20(30)
Coursework before entering medical school	15(22)
Everyday exposure to mainstream media	12(18)
Coursework in medical school class	11(16)
Other	7(10)
Physician or healthcare provider	2(3)
Previous job or volunteer activity	0(0)
Primary – Other Sources	
Family	6(9)
Gym Trainer	1(1)
Secondary	
Everyday exposure to mainstream media	21(31)
Self-directed education about nutrition	15(22)
Coursework in medical school class	14(21)
Coursework before entering medical school	6(9)
Physician or healthcare provider	5(8)
Other	3(5)
Previous job or volunteer activity	2(3)
Secondary – Other Sources	
Family	2(3)
Research	1(1)

*Data are Number of Students (% of all Respondents).

dieticians' professional roles and increased their willingness to refer their future patients to a dietician. Moreover, seeing their own blood lipid and glucose measurements caused many of the students to contemplate lifestyle changes to improve their diet and exercise. Finally, the survey of sources of nutritional information confirmed the need to improve both the teaching of nutrition in medical schools and the use of nutritional counseling as part of medical practice.

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Satisfaction with Life During the First Two Years of Medical School Based on Sleep, Diet, and Exercise and Current Adherence to Future Patient Advice

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ABSTRACT

Medical student satisfaction with life during their training may be compromised as they attempt to endure the rigors and challenges afforded by a demanding medical school curriculum. The purpose of this study is to examine satisfaction with life during the first two years of medical school and to assess sleep, diet, and exercise as predictors of this satisfaction. A thirty-one item survey was developed and distributed to first and second year medical students at the University of Kentucky College of Medicine in 2004. Data analysis indicated that the major predictor of satisfaction in the first year class was sleep differential, defined as the actual amount of sleep per night subtracted from the ideal amount of sleep per night. The major predictor for second year students, on the other hand, was the amount of sleep per night. Although the results of this survey showed no strong correlations between satisfaction with life and diet, sleep and exercise did show statistically significant correlations. Participants in this survey exercised and ate adequately for one section of the food pyramid; however, they failed to comply with the recommended hours of sleep per night and all other sections of the food pyramid.

INTRODUCTION

Satisfaction with life is shaped by a variety of factors, including sleep, diet, and exercise. Individuals who experience sleep deprivation, while maintaining poor dietary and exercise practices may have difficulty in expressing satisfaction with life. Societal stereotypes concerning the stress of medical school have existed for many years, raising questions concerning medical students' satisfaction with life during the early stages of their education. To explore this question, we designed a survey examining several predictors (i.e. sleep, diet, and exercise) that relate to student satisfaction with life during the first two years of medical school.

Sleep

Physical and mental restoration, as well as energy conservation, are the main functions of sleep. Sleep is defined as a physiologic state of relative unconsciousness and inaction of the voluntary muscles, the need for which recurs periodically[1]. The recurring need for sleep varies among people according to their genetic makeup, age, medications taken, and gender. Signs of sleep deprivation include regular use of an alarm clock, more than a one hour difference in weekend versus weekday sleep time, and excessive use of caffeine. The effects of sleep deprivation may be particularly difficult for students, considering studies have shown that people perform worse on serial addition testing after sleep loss and tasks of longer duration are more likely to show the effects of sleep deprivation[2]. Therefore, sleep deprivation could have negative manifestations during long exams. Other studies have shown that residents who work longer hours are more dissatisfied with their work and can have decreased motivation to learn[2]. These studies have also indicated post-call residents were less likely to take comprehensive histories and were more prone to document less on physical exam[2]. Therefore, we hypothesize that similar results will be found at the earlier stages of medical education and that medical student satisfaction with life during the first two years of medical school will correlate with what the student deems as an appropriate amount of sleep.

Diet

Medical students should practice sound eating habits not only for personal health but also to serve as role models to their future patients and to enhance their performance in the classroom. One study utilized a questionnaire to assess the foods that students eat and their satisfaction with their diet[3]. Results from this study showed that females on average consumed more fruits, vegetables, dairy products, poultry, and fish compared to males.[3] In contrast, males ate more animal fat and red meat, and consumed nearly twice the quantity of food as females[3]. According to the results of the questionnaire, females were more compliant with recommendations from the Institute of Food and Nutrition than males, while males were more satisfied with their dietary habits than females[3]. Another study designed to assess gender differences in eating habits found that both sexes ate smaller quantities of fish, peas, beans, and milk than recommended by the Institute of Food and Nutrition, but like the previous study, indicated that males consumed more meat. Males had a higher intake of sweet drinks and alcohol than females[4]. Finally, a similar study found women ate more cottage cheese and whole grain bread while men ate more meat, potatoes, and drank more alcohol. Also, overweight men and women ate fewer meals with less fruits and vegetables[5]. In addition, a study with medical students showed vitamin A, E, C, B6, B12, and Folic acid intake to be lower than the recommended level, with female students consuming significantly lower amounts of these vitamins than their male counterparts[6]. It is hypothesized that students who consume a more balanced and healthy diet, specifically consisting of more fruits and vegetables, will lead a more satisfying lifestyle during the first two years of medical school.

Exercise

Exercise, defined as any bodily exertion for the sake of restoring the organs and functions to a healthy state or keeping them healthy[1], has been correlated with well-being in a multitude of studies[7] Frank and coworkers state that medical students are more active than the population as a whole[8] . A different study also showed that exercise is tightly linked to the other variable examined in this study, i.e. sleep. Exercise leads to better sleep due to increased fatigue, decreased BMI (body mass index) which is correlated with sleep apnea[9], and decreased incidence of insomnia[10]. Therefore, we hypothesize that increased exercise by medical students would lead to increased satisfaction with the medical student lifestyle during the first two years.

MATERIALS AND METHODS

A thirty-one item survey was developed by eight second-year medical students at the University of Kentucky College of Medicine (UKCOM). This survey measured a variety of variables using the satisfaction with life scale[11]. These questions were grouped into four categories: sleep, exercise, diet, and satisfaction with life (Appendix 1). An exemption certification for this study was granted from the UKCOM Institutional Review board, approval number 05-0021-X3G. The subjects consisted of first and second year medical students from the classes of 2007 (n=67) and 2008 (n=90) UKCOM. Each class was approached with the request for students to complete the voluntary survey in their respective lecture halls. A cover letter was provided with each survey, describing the survey and its justification. The study group included 157 surveys received from 195 distributed (80.5% response rate). Seventy four respondents were female and eighty- three were males. Twenty one percent of the respondents were married, while seventy nine percent were single. Statistical analysis was performed on the data using correlations, t-tests, and stepwise regression using SPSS 13.0.

RESULTS

The first year medical class differed significantly from the second year medical class in two of the parameters measured: the second year class reported a higher incidence of falling asleep during lectures ($p = 0.023$), while the first year medical students reported higher scores on the Satisfaction with Life Scale ($p = 0.002$). For all other measures the two classes were identical. The means of the measures are shown in Table 1.

When data from both classes were combined and applied to the stepwise regression model, two variables were found to be predictive for the Satisfaction with Life Scale. Sleep differential (defined as the difference between the amount of sleep obtained and the amount of sleep desired) and the extent to which exercise influences happiness had a combined R square value of 0.312. However, this is not the case for each class individually.

Several parameters for the first year class correlated significantly with the Satisfaction with Life Scale, where $r=0.258$ (Table 1). These significant parameters include: 1) the amount of sleep per night, 2) optimal amount of sleep per night, 3) feelings of sleepiness while driving, 4) minutes of aerobic exercise per week, 5) minutes of anaerobic exercise per week, 6) self-perception of overall fitness , 7) beliefs on the extent to which exercise influences satisfaction and 8) sleep differential. Application of these parameters into a stepwise regression model revealed that the sleep differential and the extent to which students believed exercise impacted their satisfaction were the best predictors of student satisfaction with life. The regression model showed that for 31.2% of the surveyed first-year medical students, satisfaction could be predicted by these two parameters. All other variables concerning the postulated hypotheses were not significant. Only one parameter (amount of sleep per night) correlated with the Satisfaction with Life Scale for the second year class. When second year data was applied into the stepwise regression model, no single variable emerged as the best predictor of student satisfaction.

DISCUSSION

The survey results indicate that both first and second year medical students receive an average of 6.3 hours of sleep per night, however the range was 4-9 hours per night, supporting the idea that recurring need for sleep varies greatly among the students with genetics, age, medications, and even

Table 1. Mean and Correlation Values of Survey Categories

#Mean values represent averages from collective information using the appended survey. ^Correlation values based on stepwise regression performed on survey results from first and second year medical students.

Survey item	*Mean*	*R values for first year student (n=67)*	*R values for second year students (n=90)*
Age (years)	24.37	0.009	0.043
Sleep per night (hours)	6.29	0.277**	0.287*
Optimal sleep per night (hours)	7.59	-0.226**	0.019
Sleep during lecture (1=always, 3=never)	2.37	-0.108	0.211
Caffeine (cups per day)	1.96	-0.129	-0.094
Naps (per day)	1.50	0.038	0.030
Sleepy while driving (1=always, 3=never)	2.35	0.292**	0.097
Extra weekend sleep (hours)	2.21	-0.194	-0.093
Poultry (servings per day)	1.06	0.027	-0.016
Beef (servings per day)	0.62	0.028	-0.197
Pork (servings per day)	0.22	-0.065	-0.025
Fish (servings per day)	0.44	0.008	-0.209
Bread/pasta (servings per day)	2.87	-0.085	-0.016
Fruit (servings per day)	1.72	0.059	0.205
Vegetables (servings per day)	1.91	0.026	0.185
Vitamins (servings per day)	0.62	0.038	-0.130
McDonalds (servings per day)	0.36	0.077	-0.221
Exercise (minutes per day)	34.21		
Aerobic (minutes per week)	99.78	0.258*	-0.016
Anaerobic (minutes per week)	80.72	0.276*	-0.027
Overall fitness (1=poor, 5=excellent)	2.84	0.313**	0.054
Exercise affects satisfaction (1=strongly decreased, 5=strongly increased)	4.14	0.337**	0.102
Satisfaction with Life Scale (1=strongly disagree, 7=strongly agree)	4.98		
Sleep differential (hours)	1.39	-0.480**	-0.125

* Correlation significant at 0.05 level (2-tailed)
**Correlation significant at 0.01 level (2-tailed)

gender contributing to these differences. Also, according to the sleep differential (desired hours of sleep – actual hours of sleep per night), medical students would prefer to have 1.4 additional hours of sleep every night, suggesting possible sleep deprivation. When the data set is further analyzed by segregating the first and second year medical students, the sleep differential is a major predictor of first year well being. The lower the sleep differential, i.e. the closer the actual and desired hours of sleep per night, the more satisfied these students were with subjective well being. However, the second year medical student subjective well being was more highly correlated with total hours of sleep per night.

The present results support our hypothesis that exercise could increase life satisfaction among medical students because exercise has been shown to increase wellness in the general population. Exercise was one of only two variables in this study that did correlate with life satisfaction. Combined with sleep differential, exercise accounted for over 29% of medical student life satisfaction. This is a significant finding and leads us to the conclusion that despite their busy course schedule, medical students should make time to exercise for their overall well-being.

Another interesting consideration is whether the students at this stage of life start to practice a lifestyle which they may be advocating to patients in the future. The Center for Disease Control recommends exercising 20-30 minutes 3-5 times per week[12]. According to the survey, both first and second year medical students, exercised 34 minutes per day on average matching this recommendation and indicating how important exercise is to the students. The food pyramid indicates that people should eat: 2-3 servings per day of meat, poultry, fish, dry beans, eggs & nuts; 3-5 servings of vegetables; 2-4 servings of fruits; and 6-11 servings of bread, cereal, rice, and pasta[14]. Medical students eat 2.34 servings, 1.91 servings, 1.72 servings, and 2.87 servings per day, respectively. Consequently, medical students only meet the food pyramid criteria for meat, poultry, fish, dry beans, eggs & nuts but fall short in all other categories. The recommended number of hours of sleep per night is eight hours[13]. According to the survey, medical students average 6.3 hours of sleep per night, therefore falling short of this recommendation, though this is undoubtedly related to the specific lifestyle the medical students are leading and may not apply to the general patient population. Medical students excel in daily requirements for exercise, but fall short in nearly all of the remaining life parameters they may be emphasizing to their future patients.

LIMITATIONS

Although the results are suggestive of exercise and sleep components to the satisfaction of life for the medical students in the first two years, one possible limitation to this study could be timing. First year students took the survey a few days after completing a major examination, while they were in a "recovery phase." Moreover, second year students took the survey on an examination day when most of them were seemingly stressed. Thus, timing for completing the survey may have affected the results of the study. Also, the study was limited to a single first year and second year class; a larger sample size may yield different results. Another possible limitation was student misinterpretation of some of the survey questions, particularly regarding the definition of anaerobic exercise, differences between mild, moderate, and strenuous exercise, and regarding frequency of food servings.

FUTURE STUDIES

Future studies should broaden the present study to include more schools and more variables in the study. Different types of exercise could be examined, i.e. aerobic versus anaerobic. Also, other aspects of life like entertainment, leisure activity, and spirituality could be examined. Types of fad diets, like Atkins, South Beach, the Zone, and Ornish, could also be factored into the diet analysis.

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Appendix

Medical Student Survey

Dear medical student,

Thank you for participating in this research survey. This survey is designed to measure several parameters that might affect the lives of medical students. Your participation should require approximately ten minutes. You can participate by filling out the survey according to the directions included. This survey will put you at no risk. The survey might benefit you by providing new information on the lives of medical students like you. This survey is anonymous, although the results will be examined and may be published.

Your participation is completely voluntary. You may refuse to participate without incurring any penalty or loss of benefits. You may discontinue the survey at any time if you change you mind.

The survey has been assembled by members of the MD 820 Patients, Physicians, and Society II class led by Dr. Webster. The students are Jeff Chamberlain, Matt Dawson, Karrie Grear, Andrew Harris, Michael Owen, Iman Perry, Elizabeth Rechtin, and Ben Thompson. If you have any questions about this research project or your rights as a participant, you may contact Dr. Webster at (859)323-1457 or the Office of Research Integrity at (859) 257-9428.

Thank you.

MEDICAL STUDENT SURVEY

The following survey is specifically designed to assess numerous variables related to medical student education and academic performance. Thank you for taking a few moments to complete this survey. Your input is very valuable to us!

1. Gender: M____ F_____

2. Age _________

3. Marital Status: Married _______ Single ________

4. Expected year of graduation from medical school: __________

5. Approximately how much sleep do you get each night during the week? _____ hours

6. How much sleep do you think you ***should*** get each night during the week? _____ hours

7. Do you fall asleep in lecture? Always sometimes never (circle one)

8. I have ___ cups of caffeine every day: 0 1-2 3-4 5 or more (circle one)

9. I take naps: _______ times/day 0 1 2 3 >3 (circle one)

10. I feel sleepy driving: always sometimes never (circle one)

11. On the weekends, I get ___ hours (more/less) of sleep per night as compared to weeknights.
    For example: On the weekends, I get 2 hours MORE of sleep per night as compared to weeknights.

FOR QUESTIONS 12-20, USE THE FOLLOWING SCALE:

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Less 1 serving/day	1 serving/day	2-3 servings/day	4-5 servings/day	5-6 servings/day	7-8 servings/day	9-10 servings/day	more than 10 servings/day

12. How often do you consume poultry? (1 serving is 2-3 oz cooked) _______

13. How often do you eat beef? (1 serving is 2-3 oz cooked) _______

14. How often do you eat pork? (1 serving is 2-3 oz cooked) _______

15. How often do you eat fish? (1 serving is 2-3 oz cooked) _______

16. How often do you consume bread and/or pasta? (1 serving is 1 slice of bread, ½ cup pasta, or ½ bagel or English muffin) _______

17. How often do you eat fruits? (1 serving is 1 medium sized banana, apple, or orange, ½ cup canned or cooked fruit, ¾ cup fruit juice) _______

18. How often do you eat vegetables? (1 servings is 1 cup of leafy vegetables, ½ cup raw or cooked vegetables, or ¾ cup of vegetable juice) _______

19. How often do you take a supplemental vitamin? _______

20. How often do you consume fast food? _______

FOR QUESTIONS 21-25 USE THE FOLLOWING SCALE:

7 - Strongly agree	6 – Agree	5 – Slightly agree	4 – Neither agree nor disagree	3- Slightly disagree	2 – Disagree	1 – Strongly disagree

______ 21. In most ways my life is close to ideal.
______ 22. The conditions of my life are excellent.
______ 23. I am satisfied with my life.
______ 24. So far I have gotten the important things I want in life.
______ 25. If I could live my life over, I would change almost nothing.

26. How many min/day on average do you exercise? _______

27. How many min/week do you perform aerobic exercise? _______

28. How many min/week do you perform anaerobic exercise? _______

29. On a scale of 1-10, with 10 being your maximal exertion, how many min/week do you engage in:

Mild exercise (1-3)?	Moderate exercise (4-7)?	Strenuous exercise (8-10)?

30. How would you rate your overall physical fitness (circle one)?

Poor Average Good Very Good Excellent

31. How do you feel that exercise affects your overall satisfaction in medical school (circle one)?

Strongly Decreased Slightly Decreased No affect Slightly Increased Strongly Increased

Osteopathic Medical Students and the Allopathic Licensing Examination

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ABSTRACT

This study addresses three questions: 1) what is the trend for Kansas City University of Medicine and Biosciences (KCUMB) students taking the USMLE series since 1999? 2) what are the reasons KCUMB students either take or do not take the USMLE? 3) does COMLEX-USA performance predict USMLE performance and vice versa for KCUMB students taking both exams? Corresponding COMLEX-USA Level I and II and USMLE Step 1 and 2 scores from KCUMB students (N = 1,210) were obtained and analyzed, using a Pearson correlation test. First- through fourth-year students (n = 918) were asked to complete an online survey about their reason(s) for taking or not taking the USMLE. Over the past six years, the percentage of KCUMB students taking the USMLE, Step 1 and Step 2 examination, has risen from 13.97% and 1.68% to 47.83% and 16.43%, respectively. The two most popular responses for taking the USMLE were: being more competitive for allopathic residencies and keeping all options open. For the same time period, the Pearson product moment correlation between COMLEX-USA Level 1 and USMLE Step 1, and COMLEX-USA Level II and USMLE Step 2 were 0.88 ($P < 0.001$) and 0.82 ($P < 0.001$), respectively, for KCUMB students. The significant correlation between COMLEX-USA and USMLE performance suggests predictive validity between the two examination series.

INTRODUCTION

The Comprehensive Osteopathic Medical Licensing Examination (COMLEX-USA) is a set of examinations used to assess medical knowledge and clinical skills of those who are seeking a degree in osteopathic medicine.[1] The COMLEX-USA was introduced in 1995 to replace the National Board of Osteopathic Medical Examiners (NBOME) series. Design of the COMLEX-USA series has been reported to be the most appropriate pathway for licensure of osteopathic physicians.[2]

COMLEX-USA is a tri-level examination series. Levels I, II, and III are intended to be administered at the conclusion of the second year of medical school, during the fourth year of medical school, and during the first post-graduate year, respectively. All osteopathic medical schools require passage of COMLEX-USA Level I for advancement to the third year of medical school, and nine schools require passage of COMLEX-USA Level II for graduation.[3] Examinees taking the COMLEX-USA must be enrolled in an accredited osteopathic institution.[4]

The allopathic counterpart to the osteopathic COMLEX-USA is the United States Medical Licensing Examination (USMLE). The USMLE series also consists of three parts and its temporal sequence is similar to the COMLEX-USA series. It is intended to assess "a physician's ability to apply knowledge, concepts, principles, and to demonstrate fundamental patient-centered skills."[5] Unlike the COMLEX-USA, the USMLE is open to both allopathic and osteopathic students and residents.[5]

The COMLEX-USA and the USMLE are used by internship/residency personnel as screening devices for applicant selection. Residency performance has been reported to correlate with USMLE performance.[6,7] However, to our knowledge, no published data exists on the relationship between COMLEX-USA scores and residency performance.

As a graduate from an osteopathic medical school, one can choose to pursue post-graduate training at either an American Osteopathic Association (AOA)-accredited institution, or an Accreditation Council for Graduate Medical Education (ACGME)-accredited institution. According to data compiled by the AOA Division of Postdoctoral Training, the number of college of osteopathic medicine graduates increased from 2,405 to 2,628 between the years 1999 to 2003.[8] The same report showed that the number of AOA approved internship positions increased from 2,346 to 2,659. However, the number of osteopathic graduates entering AOA approved internships decreased from 1,502 to 1,440.[8]

Kansas City University of Medicine and Biosciences College of Osteopathic Medicine (KCUMB) is one of nine osteopathic medical schools that require successful passage of COMLEX-USA Level I and Level II to graduate.[3, 9] Passage of USMLE Steps 1 and 2 is neither required, nor is it a substitute for the COMLEX-USA requirement. Yet, some KCUMB students elect to take the USMLE series.

Using Educational Resources Information Center (ERIC) and MEDLINE, we have found no published data that have either reported the number of osteopathic students taking the USMLE, or examining the reason(s) why osteopathic medical students take the USMLE. Additionally, it is not known whether COMLEX-USA performance is predictive of USMLE performance and vice versa. This study addresses these three questions: 1) what is the trend of KCUMB students taking the USMLE series since 1999? 2) what are the reason(s) KCUMB students either elect to take or not take the USMLE? 3) does COMLEX-USA performance predict USMLE performance and vice versa for KCUMB students taking both exams? Grant funding was not required to conduct this investigation. Results from this study will further medical education knowledge for both the allopathic and osteopathic communities by: 1) exploring a possible correlation between the USMLE and COMLEX-USA scores, and 2) explaining the possible reason(s) some osteopathic students elect to take the allopathic licensing exam.

Materials and Methods

This study used both qualitative and quantitative data to address the three research questions. De-identified COMLEX-USA Level I and Level II scores (n = 1,210) as well as USMLE Step 1 (n = 443) and Step 2 scores (n = 178) for all students in the graduating classes of 1999 to 2004 (n = 1,210) were obtained from the KCUMB Registrar's office. Data prior to 1999 was not available electronically; therefore was not included in the study. To examine the trend of KCUMB students taking the USMLE Step 1 and Step 2 over the past six years, class percentages were calculated. The number of students in each graduating class who took the USMLE Step 1 and/or Step 2 was divided by the total number of students in each class.

The reason(s) osteopathic medical students elect to take or not take the allopathic licensing exam was determined via an online-survey using Formsite.com. The survey consisted of two open-ended questions and three closed-ended questions. (Fig. 1)

Before any data was collected, a protocol was prepared in accordance with KCUMB IRB guidelines[10] and subsequently underwent a full review. Once IRB approval was obtained (#04-21), the survey was placed online (www.formsite.com) and piloted as a data control measure before contacting KCUMB students. The online survey ensured student anonymity and provided internal validity to the investigation. The *Professional 2* level of Formsite was used to avoid multiple entries from the same student. A general e-mail letter was sent to all enrolled KCUMB students (n = 918), inviting them to participate in the study. A description of the study and a hyperlink to the survey were included in the e-mail invitation.

First-year (n = 239), second-year (n = 227), third-year (n = 214), and fourth-year (n = 238) students were given one month to complete the online survey. KCUMB-IRB granted permission to send out three reminder notices during the one month data collection period. These e-mail reminders were sent out at the conclusion of the first, second, and third weeks of the study. Completed Formsite surveys were downloaded into a Microsoft Excel® spreadsheet.

Answers to the three closed-ended questions were tallied according to categorical responses and year of medical training. Subsequently, all closed-ended responses were converted to percentages. Open-ended answers were grouped according to similarity of response(s), tallied by year of medical training, and converted into percentages.

To determine whether a correlation existed between COMLEX-USA Level I and Level II scores and corresponding USMLE Step 1 and Step 2 scores, a Pearson Correlation test was used. Because of possible interclass academic variability, a mean Pearson product correlation coefficient for both Level I/Step 1 and Level II/Step 2 was determined (i.e., Pearson product correlation coefficient for both examination levels for each class was summed and divided by the total number of classes [6]).

Results

The number of students in each of the six graduating classes (n = 1,210) that were studied and the corresponding number of students who took the USMLE, Step 1 (n = 443) and/or Step 2 (n = 178) are shown in Table 1. Because of the variable number of students in each class, we calculated percentages of students who took the USMLE, Step 1 and/or Step 2. From 1999 to 2004, the percentage of KCUMB students taking the USMLE, Step 1 and Step 2 examination increased from 13.97% and 1.68% to 47.83% and 16.43%, respectively (Fig 2).

Figure 1. Sample of Survey on Formsite.com (Survey for 1st year Students)

To which type(s) of residency program(s) are you planning on applying?

- ☐ Osteopathic residencies only
- ☐ Allopathic residencies only
- ☐ Osteopathic and allopathic residencies
- ☐ I don't know

Are you planning on taking USMLE Step 1?

- ☐ Yes
- ☐ No

Why are you planning to take or not take USMLE step 1?

Are you planning to take USMLE Step 2?

- ☐ Yes
- ☐ No

Why are you planning to take or not take USMLE Step 2?

To better understand why some KCUMB students take the USMLE series and others do not, currently enrolled first- through four-year students were asked to complete an online survey. The response rate for first-, second-, third-, and fourth-year students was 64.85% (155 of 239 students), 78.41% (178 of 227 students), 56.54% (121 of 214 students), and 57.98% (138 of 238 students), respectively. Five hundred and ninety-two students from a total of 918 students (64.49%) completed the survey. Survey responses were grouped by year of medical training and categorized by either reasons for taking the USMLE or not taking the USMLE (Table 2). More than 50% of survey respondents plan to apply to both osteopathic and allopathic residencies. Two-thirds of students who completed the survey either took or plan to take USMLE, Step 1. However, about one third of students either took or plan to take USMLE, Step 2. "Being more competitive for allopathic residencies" and "keeping all options open" were the two most common responses for taking the USMLE series. The two most common responses that students listed for not taking the USMLE series were "no perceived benefit for taking the examination" and "no interest in entering a residency that did not accept COMLEX-USA scores."

To determine whether there was a relation between COMLEX-USA and USMLE performance, a Pearson Product correlation test was conducted for students who took both examinations. Correlation Coefficients for both examination levels of each class are presented in Table 3. Because of potential interclass academic variability, a mean Pearson product moment correlation coefficient was determined for both examination Steps/Levels. The mean Pearson product moment correlation between COMLEX-USA-Level I and USMLE-Step 1, and COMLEX-USA-Level II and USMLE-Step 2 were 0.88 ($P < 0.001$) and 0.82 ($P < 0.001$), respectively.

DISCUSSION

There were three reasons for conducting this study: 1) to look at the trend of KCUMB students taking the USMLE series since 1999 to the present, 2) to investigate the reason(s) KCUMB students either choose to take or not take the USMLE, and 3) to investigate whether COMLEX-USA performance predicts USMLE performance and vice versa for KCUMB students taking both exams. To address these research questions, we designed a descriptive study that was both quantitative and qualitative in nature. De-identified quantitative data (e.g., COMLEX-USA and USMLE scores) were obtained from the KCUMB Registrar's office. Qualitative data were obtained from an online survey (i.e., reasons for taking or not taking USMLE series), consisting of three closed-ended and two open-ended questions. A limitation of the open-ended survey questions was correctly interpreting variable student responses (Table 2). Most student responses to the two open-ended survey questions were easily grouped based on student choice of words. Those responses that did not fit into major categories were grouped as "other" (e.g., "the cost for taking both exams was too great"). To our knowledge, there are no directly related published studies from which to make research hypotheses based on scientific merit. Therefore, our research hypotheses to the questions framed for this study are based on indirect evidence and reasonable assumptions.

The first research question pertained to the trend of KCUMB students taking the USMLE exam series. According to published data from the AOA Division of Postdoctoral Training, the number of AOA-approved post-graduate training programs has increased, while fewer osteopathic medical graduates are entering these programs.[8] Additionally, data from the American Medical Association shows an increase in the number of osteopathic graduates entering ACGME (allopathic) approved post-graduate

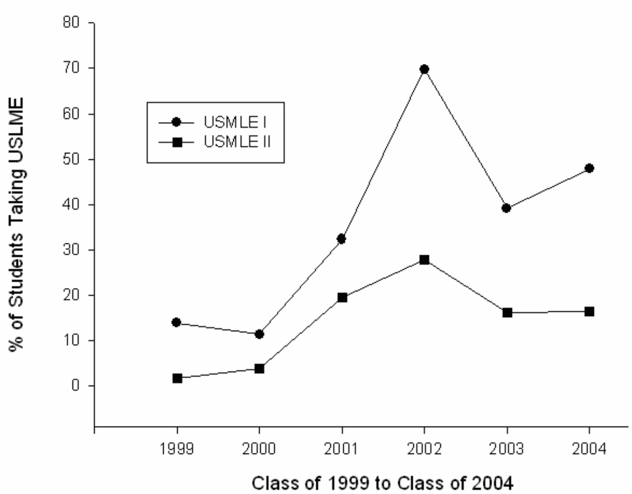
Table 1. Graduating Class Size and Number of Students Taking USMLE, Step 1 and/or Step 2.

Graduating Class (Year)	Class Size (n)	Students Who Took USMLE, Step 1 (n)	Students Who Took USMLE, Step 2 (n)
1999	179	25	3
2000	201	23	8
2001	204	66	40
2002	215	150	60
2003	204	80	33
2004	207	99	34
Totals	1,210	443	178

training programs.[3] Obradovic and Winslow-Falbo[11] suggest several reasons why students are choosing to enter ACGME-accredited programs rather than AOA-accredited programs. Some students believe ACGME-approved programs are of higher quality. Other reasons cited include undesirable geographic locations and/or insufficient diversity of AOA-approved programs. Because of the increased number of osteopathic students entering allopathic residencies, we hypothesized a rise in the number of KCUMB students taking the USMLE Step 1 and/or Step 2. Results from this investigation show that from 1999 to 2004, the percentage of KCUMB students taking the USMLE, Step 1 and Step 2 has increased three-fold and nine-fold, respectively (Fig. 2). For all six years examined, however, more KCUMB students took USMLE Step 1 compared to Step 2. Survey results indicate that many students do not consider USMLE Step 2 as important as Step 1 in being competitive for allopathic residencies (Table 2).

The second research question considered the reason(s) why KCUMB students either take or not take the USMLE. USMLE Step 1 and Step 2 scores are neither required for graduation at KCUMB, nor are they substitutes of the COMLEX-USA requirement for academic advancement and graduation.[9] Because the number of osteopathic students entering AOA-approved post-graduate training programs is decreasing and the number of graduates entering ACGME-approved post-graduate training programs is increasing, we hypothesized a majority of respondents would affirm a need to take the USMLE in order to be also competitive for allopathic residency programs.

Figure 2. KCUMB Students Taking USMLE



Survey results showed that nearly one-half of respondents (n = 191) had either taken, or were going to take USMLE Step 1, "to be a competitive applicant for allopathic residency positions." Additionally, more than one-third of respondents (n = 154) reported they were either taking or had taken the USMLE Step 1, "because they wanted to keep their options open." Presumably, these findings indicate that students who are applying to ACGME-accredited programs believe they will be more competitive if they take USMLE Step 1, hence, possibly explaining why more KCUMB students are taking USMLE Step 1 compared to Step 2 (Fig. 2). The majority of first- through fourth-year respondents who did not take or were not planning to take the USMLE Step 1 (n = 110), perceived no benefit to taking this test (Table 2). Due to how the data were tabulated and downloaded from formsite.com, we do not know which residency programs these students plan to pursue (i.e., osteopathic and/or allopathic).

Survey results (Table 2) and retrospective data (Fig. 2) show that fewer students are taking or have taken USMLE Step 2 compared to Step 1. The most populous reason cited for taking USMLE Step 2 was "to be a competitive applicant for allopathic residency positions" (Table 2). This finding suggests that fourth-year students who are applying to allopathic residency programs may not consider Step 2 as important as Step 1 for being a competitive applicant. Forty-four percent of first- through fourth-year students who did not take or do not plan to take the USMLE Step 2 indicated "they do not feel that there was a benefit to taking the USMLE." Although beyond the scope of our survey, we propose several reasons why osteopathic students do not consider USMLE Step 2 beneficial when

Table 2. Survey Responses

Questions and Responses	First-Year Students	Second-Year Students	Third-Year Students	Fourth-Year Students	Totals
To which residencies will/did you apply?					
Osteopathic Only	8 (5%)	24 (13%)	8 (7%)	19 (14%)	59 (10%)
Allopathic Only	21 (14%)	11 (6%)	29 (24%)	78 (57%)	139 (23%)
Osteopathic and Allopathic	98 (63%)	107 (60%)	72 (60%)	40 (29%)	317 (54%)
Not sure	28 (18%)	36 (20%)	12 (10%)	1 (1%)	77 (13%)
Are you taking/Did you take USMLE Step 1?					
Yes	123 (79%)	105 (59%)	86 (71%)	85 (62%)	399 (67%)
No	32 (21%)	73 (41%)	35 (29%)	53 (38%)	193 (33%)
Reasons for taking USMLE Step 1?					
To keep all options/ opportunities open	39 (32%)	51 (49%)	42 (49%)	22 (26%)	154 (39%)
To be a competitive applicant for allopathic residency positions	64 (52%)	37 (35%)	37 (43%)	53 (62%)	191 (48%)
To compare oneself or to prove a point	12 (10%)	12 (11%)	5 (6%)	9 (11%)	38 (10%)
Other	8 (7%)	5 (5%)	2 (2%)	1 (1%)	16 (4%)
Reasons for not taking USMLE Step 1?					
Planning on entering Osteopathic Residency	5 (16%)	12 (16%)	0 (0%)	4 (8%)	21 (11%)
Do not perceive a benefit to taking the exam	17 (53%)	38 (52%)	23 (66%)	32 (60%)	110 (57%)
Would not attend residency that did not accept COMLEX scores	4 (13%)	20 (27%)	9 (26%)	12 (23%)	45 (23%)
Other	6 (19%)	3 (4%)	3 (9%)	5 (9%)	17 (9%)
Reasons for not taking USMLE Step 2?					
Planning on entering Osteopathic Residency	5 (13%)	9 (7%)	2 (2%)	10 (9%)	26 (7%)
Do not perceive a benefit to taking the exam	23 (61%)	51 (40%)	36 (42%)	48 (44%)	158 (44%)
Will not/Did not take or pass USMLE Step 1	0 (0%)	18 (14%)	19 (22%)	25 (23%)	62 (17%)
Application to residency does not contain Step 2 scores	2 (5%)	14 (11%)	7 (8%)	14 (13%)	37 (10%)
Would not attend residency that did not accept COMLEX scores	2 (5%)	18 (14%)	7 (8%)	6 (5%)	33 (9%)
Other	6 (16%)	16 (13%)	14 (16%)	7 (6%)	43 (12%)

applying to allopathic residency programs. Some applicants may believe successful completion of Step 1 is enough to be competitive for allopathic residencies. An unknown number of allopathic residency programs may accept the COMLEX-USA along with the student's performance during clinical clerkships as sufficient without USMLE scores. A third possibility may be that the deadline for submission of residency applications often precedes receiving Step 2 scores.

Our data shows an increase in the number of KCUMB students taking the USMLE series. However, will this trend continue in the future? Although pre-clinical students (i.e., first- and second-year students) have not taken either the COMLEX-USA or USMLE series, survey results from this study indicate that 68% and 51% of these students plan to take USMLE Step 1 and Step 2, respectively (Table 2). These same data also suggest that KCUMB students will

Table 3. Pearson Product Correlation Coefficients for Students Taking both COMLEX and USMLE.

Graduating Class (Year)	COMLEX, Level I and USMLE, Step 1 (r)	COMLEX, Level II and USMLE, Step 2 (r)
1999	+0.92*	+0.84**
2000	+0.92*	+0.78*
2001	+0.88*	+0.81*
2002	+0.86*	+0.77*
2003	+0.88*	+0.82*
2004	+0.85*	+0.89*
Mean	+0.88*	+0.82*

*P < 0.01; **P > 0.05

take USMLE Step 1 and Step 2 to be competitive for allopathic residencies.

The third research question of this study was to examine whether COMLEX-USA performance predicted USMLE performance and vice versa for KCUMB students taking both exams. Because undergraduate osteopathic and allopathic medical students complete similar basic science coursework and clinical clerkships, we hypothesized a significant correlation would exist between COMLEX-USA Levels I and II and USMLE Steps 1 and 2, respectively. Results from this investigation revealed a significant correlation for both examination Steps/Levels (Table 3). Thus, data from this study demonstrate that students who perform well on COMLEX-USA are most likely to do well on the USMLE series. Conversely, KCUMB students who perform poorly to average on COMLEX-USA will most likely perform similarly on the USMLE.

Within the limitations and delimitations of this study, the following conclusions seem justified: 1) the number of KCUMB students taking the USMLE is on the rise, and this trend is likely to continue in the future, 2) students who take the USMLE Step 1 and/or Step 2 do so primarily to increase their chances of obtaining acceptance into allopathic residency programs, 3) students who do not take USMLE Step 1 and/or Step 2 do not perceive an advantage to taking the USMLE series, and 4) there is a significant correlation between KCUMB students' COMLEX-USA and USMLE scores for both the first and second series.

Collectively, the conclusions from this study have theoretical and practical implications. The theoretical implication of this study is that the correlation between COMLEX-USA and USMLE scores gives predictive validity to the two types of examinations. Practically, residency program committees who use national board examination scores as a benchmark for comparing allopathic and osteopathic applicants may consider COMLEX-USA performance predictive of USMLE performance.

Based on the methodology of this study and its conclusions, we put forth two major recommendations for future investigations. Because the results of this study reflected the views of over 500 osteopathic medical students from only one medical school, we recommend that the study be replicated at other osteopathic institutions to assess its external validity. Second, other questions that should be addressed in future studies include: 1) is it necessary for osteopathic students to take the USMLE series to be accepted into allopathic residency programs, 2) are osteopathic medical students more competitive for allopathic residency programs if they perform well on the USMLE series and what weight allopathic residencies may place on Step 2 USMLE scores, 3) why are osteopathic graduates choosing to enter ACGME-accredited residency programs rather than AOA-approved residency programs, and 4) does COMLEX-USA performance predict residency performance?

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Table 4. Mean Class COMLEX and USMLE Scores (± Standard Deviation)

Graduating Class (Year)	COMLEX, Level I	USMLE, Step 1	COMLEX, Level II	USMLE, Step 2
1999	561.03 (90.65)	197.32 (23.65)	527.27 (70.15)	198.00 (16.37)
2000	532.72 (67.05)	210.35 (17.91)	525.87 (75.67)	198.13 (31.23)
2001	533.50 (69.56)	204.44 (18.98)	532.59 (70.32)	212.88 (20.81)
2002	530.72 (63.78)	196.79 (18.24)	504.54 (57.55)	204.33 (19.40)
2003	526.05 (60.42)	201.80 (20.35)	519.04 (66.58)	207.15 (20.82)
2004	525.85 (70.97)	202.68 (20.18)	506.10 (63.38)	209.74 (25.43)
Mean	534.98 (70.41)	202.23 (19.89)	519.24 (67.28)	205.38 (22.34)

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