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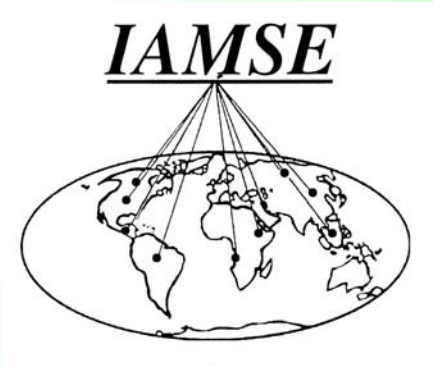

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The Journal of the International Association of Medical Science Educators

Volume 13 **Number 1** **2003**

Message from the President

Giulia A. Bonaminio, Ph.D.

Several weeks ago I attended our medical student spring formal, an annual event at which students recognize and honor the best teachers and courses in all four years of our curriculum. As the names were called and those receiving awards rose from their seats and stepped forward, I noted that several were members of IAMSE. These faculty members were being recognized by their students for excellence in teaching, a testament to their commitment and passion for medical student education. It is this dedication in teaching which IAMSE strives to support. As the mission statement affirms, it is our purpose to advance medical education through faculty development and to ensure that the teaching and learning of medicine continues to be firmly grounded in science.

We in IAMSE take this mission seriously and make every effort to provide a multidisciplinary forum for discussion of issues affecting medical science education and medical science educators. Multiple projects and products are in progress. In April of 2002 we piloted an extremely successful series of webcast audio seminars. These 1-hour telephone conference calls supplemented by webcast PowerPoint slides are a method of exchanging vital information on timely topics in medical science education. The 2002 Winter Series, Recent Trends in Basic Science Education featured such sessions as *Defining and Implementing Competency in Basic Science Education* and *Merging Basic Science Departments: Improvement or Impairment?* http://www.iamse.org/development/as_2002winter.htm Webcast audio seminars provide information not available elsewhere and broadcast directly into your office or departmental conference room.

A cornerstone of our success continues to be the IAMSE Annual Association Meeting. Last year in Guadalajara, attendees from 18 countries enjoyed the hospitality of our Mexican hosts and participated in faculty development courses, plenary sessions and workshops highlighting topics central to medical science education. I invite you to visit the IAMSE website to read summaries of the small group sessions, view the slides and download the handouts, and to listen to the full-length presentations by invited plenary speakers. http://www.iamse.org/conf/conf6/proceedings6_message.htm The program for the July 2003 meeting hosted by Georgetown University School of Medicine promises to be just as exciting. With an expected attendance of over three hundred, participants will have the opportunity to hear from member and non-member experts in the areas of curriculum design, evaluation, and faculty development. http://www.iamseconference2003.org

The IAMSE website is another feature that contains valuable educational resources beyond just maintaining Proceedings of our Annual Association Meetings. From the "Ask an Expert" service and discipline-based objectives to a world-wide medical school locator and access to this journal, our website serves as the central site for information about IAMSE and for medical education resources applicable to medical science educators.

Last but certainly not least, we offer you JIAMSE. This international peer reviewed journal is the voice of our association and provides an avenue for publication of scholarly works by all medical science educators. Now to be published in three languages, JIAMSE disseminates the results of original research in medical science education to fellow educators around the world.

Reading this journal, participating in webcast audio seminars, and attending our meetings cannot guarantee that your name will be called at faculty member recognition award ceremonies. However, look around you. Those who are so recognized make it a part of their career plan to keep apprised of the most current and innovative strategies for teaching. It is the goal of IAMSE and its international journal JIAMSE to provide this information for the winners of tomorrow – whether or not your name is ever called.

The Medical Educator's Resource Guide

John R. Cotter, Ph.D.

During the preparation of this edition of the Resource Guide, I was reminded that many of us encounter delays downloading Web pages when using a home computer. In my experience, it is the reason that is most often cited by students for not using the Web outside of the confines of our school's computer facility. So, why is it that downloading from the World Wide Web can be slow, so slow that it might deter one from using the Internet for instructional purposes?

Michael Barclay is one of a number of specialists at our school who is responsible for keeping our computer facility in working order. Barclay explained that the speed with which information is transmitted to your computer is dependent on a number of factors including the type of modem, properties of the connecting line and the design of the Web site that is contacted.

At our school, the speed with which information is downloaded over the Internet is usually fast because the phone line that is used is capable of carrying information at a rapid rate. In contrast, residential telephone lines are much slower. According to Barclay, phone lines were not meant to carry a digital signal and are the slowest way of sending information over the Internet. In effect, using a standard phone line creates a bottleneck that slows the transfer of information.

The inherent design of the site is another factor that affects download speed. A Web browser, such as Netscape Communicator, builds a Web page on the computer screen from information in files at the target site. The files contain computer language called HyperText Markup Language (HTML) and the manner in which the program code is written can affect the speed with which a page is recreated. Digitized images that are transmitted over the Internet pose another problem. The size of the image file may significantly affect the speed with which the image is reconstituted. The files of images that download slowly are likely to be large; therefore they take longer to download onto the hard drive of the computer.

The sites recommended in the MERG should download efficiently when working from a location that utilizes high-speed phone lines. If you do work online with a standard phone line and are looking to improve performance, Barclay recommends using at least a 56 Kbits modem, or upgrading to a cable modem or a DSL (Digital Subscriber Line) for faster speeds. "HowStuffWorks" is another source of information that I found useful in learning about the Internet. For more background on how computers, modems and phone lines work, the reader should consult http://www.howstuffworks.com/web-server1.htm.

If you are aware of a site that has the potential for being used by educators and students of the basic sciences, please consider contributing to the Guide. Once published by the journal, the sites and their reviews will be posted in hyperlink form on the IAMSE web site under our "Educational Resource" branch.

Send all submissions to jrcotter@buffalo.edu or use the IAMSE Web page at http://www.iamse.org/pub/bse_resource.htm. Please include the URL and a short critique of between 100 and 200 words.

All the Virology on the WWW. David M. Sander.
http://www.virology.net/garryfavweb.html

This site "seeks to be the best single site for virology on the internet." The site is a major internet resource for professional virologists and anyone seeking to learn more about viruses. Contents (in part) include links to virology research and data sites, specific virus sites, other virology sites, and educational resources in the form of virology departments/institutes, graduate programs, and on-line virology course notes and tutorials. The site features (a) "The Big Picture Book of Viruses" consisting of an extensive collection of electron micrograph images or computer-assisted graphics; and (b) "The Virology Bookshop" which lacked specific titles and was more historical than current. The site is comprehensive, clearly organized, easy to navigate, and lives up to its name.

(Reviewed by Kenneth D. Somers, Ph.D., Eastern Virginia Medical School.)

Dr. B's Histo Review. Bruce S. Babiarz. Rutgers University. The State University of New Jersey.
http://www.lifesci.rutgers.edu/~babiarz/DrBsRev.htm

This site was designed as a review site for students of an undergraduate college course in histology. It is well illustrated and organized around the concept of an electronic histology atlas. Each topic begins with a review of key morphological features. Using comparable images, this is followed, with one exception (cytology), by questions that test the user's ability to identify tissues, organs and basic structures. In addition, there are three large practical examinations. In all, there are over 800 identification type questions. Students taking a comparable level course who wish to review and test themselves with additional

specimens will find that the site is useful but should understand that the content and style of questioning is course specific. *(Reviewed by John R. Cotter, Ph.D., University at Buffalo.)*

Histology of the Periodontium. Max A. Listgarten, University of Pennsylvania and Temple University.
http://www.temple.edu/dentistry/perio/periohistology/index.html

This site is authored by Dr. Listgarten, a well-known morphologist of oral tissues, teacher and periodontist, who has an extensive knowledge of the field and understands what students, teachers and clinicians need to know about the periodontium, i.e., the gingiva, periodontal ligament, cementum and alveolar bone. This on-line course is more than a typical textbook. It attempts to clarify the most important facts and basic information on each tooth supporting tissue using photomicrographs, legends and computer teaching technology. Each section is organized into three parts: histology, clinical considerations and a short quiz. Each section contains an adequate collection of photomicrographs and starts with a diagram or a low magnification photomicrograph that orients readers to each tissue. Although some of the illustrations could be improved by increasing the contrast of the images, most of the images are of excellent quality. Being able to view them at a higher magnification is an important feature of the application. The figures are well labeled. The information on tissue structure is up-to-date, precise and clear. The clinical considerations are very relevant, useful and informative. The quiz at the end of each section gives an opportunity to review the material after study. This on-line course provides an excellent introduction to information on the periodontium. It is highly recommended. *(Reviewed by Moon-Il Cho, Ph.D, and John R. Cotter, Ph.D. University at Buffalo.)*

Internet Atlas of Histology. College of Medicine. University of Illinois at Urbana-Champaign.
http://www.med.uiuc.edu/histo/medium/index.htm

This is the web site for the histology course of the Department of Cellular and Structural Biology at University of Illinois at Urbana Champaign. The site contains a histology laboratory manual, lab quizzes for self-evaluation, an atlas and a search engine where slides can be accessed by system or histological feature. The laboratory manual is still under construction, and at the present time contains ten units: "Blood"; "Cells and Organelles"; "Connective Tissue and Epithelium"; "Lymphoid Tissue and Skin"; "Muscle and Cardiovascular System"; "Respiratory System, Bone and Cartilage"; "GI Tract, Liver, Pancreas and Gall Bladder"; "Urinary System"; "Endocrine System"; "Reproductive Systems"; and "Nervous Tissue and Special Senses". A pull down menu lists structures to be identified. These structures are highlighted and audibly identified. The lower magnifications are not particularly informative. However, the higher power views of the tissues are excellent. Highlighting of identified structures is not always obvious. The atlas includes light micrographs as well as a good number of transmission and scanning electron micrographs. The self-evaluation quizzes are quite good and the search engine is particularly useful. Overall, this is a useful site. *(Reviewed by Lois K. Laemle, Ph.D., New Jersey Medical School.)*

Promenade Round the Cochlea. **Université Montpellier**.
http://www.iurc.montp.inserm.fr/cric51/audition/english/start.htm

This is a highly graphic tour of the auditory system, created by Rémy Pujol, Valérie Réclar-Enjalbert, and Thierry Pujol. Its stated goal is to teach medical and biology students about the auditory system with a strong emphasis on the cochlea. The breadth and depth of the content is on the level of an introductory course on the anatomy and physiology of the auditory system. It shies away from the scientific rigor of many texts, which describe the experimental support for current theories and controversies in detail. Instead, it makes extensive use of hyperlinks, graphics and animations to illustrate current theories on how we hear. The tour begins with a primer on basic acoustics and quickly progresses through the anatomy of the outer and middle ear. In the next two sections, covering the cochlea and Organ of Corti, the authors combine photographs, SEM photomicrographs, schematic illustrations and animation to give a clear picture of how sound is transduced from a compression wave to neural impulses. The tour ends with an overview of the paths auditory information travels in the brain. A list of references and links to related Web sites accompany each section. **Promenade Round the Cochlea** gets a spot in my bookmarks as an accessible and instructive tour of the auditory system that is suitable for anyone from the curious undergraduate to interested physician. (Reviewed by Sam Reyes, B.S., University at Buffalo.)

The Biology Project: Biochemistry. University of Arizona.
http://www.biology.arizona.edu/biochemistry/biochemistry.html

This site demonstrates a good integration of biochemistry, molecular biology and clinical correlation with optional problem sets and tutorials. It includes a basic chemistry review; sections on biology, large molecules, and acids and bases; and clinical correlates. This site is recommended for both beginner-students and students already familiar with these subject areas. For new students in the life sciences, this site and the options within, present glossaries of relevant terms, descriptive visual diagrams and comprehensive tutorials, all of which are done in a user-friendly format. For more advance students, this site will be helpful for reviewing important concepts in the aforementioned subject areas, and offers a series of problem sets in a number of different areas. What is unique is that the problem sets and clinical correlates are presented in the context of real-life applicability that will make them attractive to those directly involved in health-care professions. Both the tests and tutorials are optional, i.e., one does not have to take the test in order to move ahead. Like many other web-based

tutorials, an incorrect answer selection automatically triggers a discussion of why the selection was incorrect. This will be particularly helpful for newer students. *(Reviewed by Wendy R. Sanhai, Ph.D., Department of Health and Human Services, National Institutes of Health.)*

An Integrated Module to Introduce Freshmen Medical Students to Breast Cancer in the First-Term of the Curriculum

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Preliminary findings were presented at the 8th International Ottawa Conference on Medical Education and Assessment (July 1998) and the 5th Annual Meeting of the International Association of Medical Science Educators (July 2001).

ABSTRACT

Breast cancer is the most common form of cancer among women in the United States. Although the basic science and physical examination aspects of breast cancer education had been included in the curriculum at the University of Arkansas for Medical Sciences for many years, the psychosocial aspects of the disease process had not been emphasized. When a new Introduction to Clinical Medicine course was added to the curriculum, the basic science and psychosocial aspects of breast cancer were interwoven into a teaching module that has proven to be very effective. The purpose of this paper is to describe this teaching module and discuss its impact.

INTRODUCTION

Breast cancer is the most common form of cancer among women in the United States and is therefore a significant public health problem. The incidence of breast cancer in the United States has been rising since the 1980s, and the National Cancer Institute estimates that one in eight American women will develop breast cancer during her lifetime.[1] Yet the breast cancer education of medical students has been reported to be fragmented and inadequate, and studies show that medical students need more training in physical examination skills and psychosocial issues.[2,7]

The initiation of an Introduction to Clinical Medicine (ICM) course at the University of Arkansas for Medical Sciences (UAMS) in 1997 provided new opportunities to teach students about breast cancer. In our institution, ICM is a required and graded two-year course that runs concurrent with the basic science curriculum. It is designed to prepare medical students for the clerkship year. The first-year curriculum emphasizes medical interviewing and physical examination skills, professionalism, and the physician-patient relationship. Students attend a weekly lecture series and meet twice each month in small groups (ten students and two clinical faculty) to practice clinical skills and discuss issues related to medical professionalism and the doctor-patient relationship.

Prior to the ICM course, first-year medical students had been exposed to the gross anatomy, microscopic anatomy, and embryology of the breast in the first semester without much emphasis on the clinical issues or the illness experiences of patients who are diagnosed with breast cancer. Training in the psychosocial issues of breast cancer patients had been sporadic and scattered throughout the four-year curriculum. As a consequence, students had difficulty integrating the basic science, clinical, and psychosocial aspects of breast cancer (UAMS College of Medicine Curriculum Committee/ICM Course Proposal, 5/31/95). In an attempt to address these issues, a breast cancer teaching module was developed that encompasses portions of three courses – Gross Anatomy, Introduction to Clinical Medicine I, and Microscopic Anatomy – that run concurrently in the first term of the first year. The purpose of the current study was to evaluate the impact of the breast cancer teaching module as presented to freshmen medical students from 1998-2001.

METHODS

A three-day breast cancer teaching module was presented to freshman medical students in the first-term of a traditional

medical school undergraduate program. The basic science foundation necessary to understand the process of breast cancer was presented to the class with little or no emphasis on the patient as a person. On Thursday (Day 1), a Gross Anatomy lecture on the thoracic wall, the breast, and its lymphatic drainage was given in the morning and followed by a dissection exercise in which the breast and pectoral region were examined grossly. In the afternoon, the students had a Microscopic Anatomy lecture on the blood vascular and lymphatic systems followed by a laboratory session designed to facilitate student understanding of the formation of tissue fluid and lymph and lymph drainage through chains of nodes.

Friday (Day 2) began with a Microscopic Anatomy lecture on the functional histology and embryology of the breast and lymph node with information on the formation of intraductal carcinoma. This lecture was followed by a laboratory session in which the histological structure of the mammary gland was studied. In the afternoon, the Chief of the Breast Service gave a clinical correlation lecture. This lecture reviewed normal anatomy information, then expanded to encompass the histopathology and clinical stages of the disease, surgical intervention (including a video of a mastectomy), and a discussion of outcomes. Students were allowed four days to process the basic science and clinical correlation information before continuing the module. During this interval, all three courses continued on their regular schedules.

On the following Wednesday (Day 3), a panel of breast cancer survivors addressed the Introduction to Clinical Medicine (ICM) class. The panel was composed of four women who had experienced breast cancer and who represented diversity in terms of race, age, socioeconomic status, time since diagnosis, and treatment regimens. They were selected and invited by the ICM course directors well in advance of the session, and they met with the course directors immediately before the session for a brief orientation. The Director of the Hematology/Oncology moderated the discussion. To begin the discussion, the women took turns introducing themselves and telling their cancer stories. Questions from students were expected, and any question was permitted. Students, who were wearing professional attire and their white coats, were asked to stand and introduce themselves before asking their questions. The women answered all questions candidly.

Different breast cancer survivors participated in the panel discussion each year, but the ability of this format to present the distinction between a disease state and the illness experience was consistent. Although two people may have the same disease (e.g. breast cancer), their illness experiences are completely different. "Disease" refers to the "pathology" of the disease: the history and physical manifestations of the disease. "Illness" refers to the patient's individual experience with the disease, as well as the effect it has on her function and how she copes. Most panelists were in remission, but three panelists were near the end of life. To remind students that women do die from this disease, the panel was named in memory of one panelist who lived with the disease for 21 years.

To promote integration of the information they had learned, students were asked to reflect on the panel discussion by responding to a journal question in an e-mail exchange with their small group faculty.[8] Immediately following the ICM session, the ICM course directors sent the students the following question: "Thinking back on the panel discussion, what is the one thing you heard from them that you hope you never forget? Why?" Students were expected to respond in writing to their faculty, with a copy to the course directors, within one week. Completion of the e-mail journal was a course requirement; student responses were not graded on content.

The breast cancer module includes knowledge, skill, and attitudinal learning objectives. Because these objectives incorporate intellectual and emotional aspects of medical practice, some are not easily measured. In each year, mastery of essential basic science and clinical knowledge was confirmed via faculty-written objective tests in all courses and communication skills were assessed during a five-station Objective Structured Clinical Examinations (OSCEs) in the ICM course. The OSCE is a practical examination to measure what a student should be able to do at an expected level of achievement, including mastery of a body of relevant knowledge and the acquisition of a range of relevant interpersonal, clinical, and technical skills. During an OSCE, each student is assessed at one or more stations with one or two aspects of clinical competence being tested at each station.[9]

Quantitative and qualitative measures of student satisfaction were used to assess the attitudinal objectives. In Fall 2000 and Fall 2001, a standardized College of Medicine lecture evaluation for basic science course lecturers was used to collect quantitative evaluation data (Table 1). Students were asked to rate the panel discussions across eight domains using a five-point Likert-type scale anchored by "5" representing "superior" and "1" representing "poor." Mean student responses were calculated for each domain.

To assess the long-term impact of the teaching module, a follow-up study was conducted with senior students who had participated in the Fall 1998 teaching module. In the spring of their senior year, these students were asked a series of questions about the impact that this teaching module had on their professional development. Five descriptors were prepared and rated on a five-point Likert-type scale anchored by "5" representing "strongly agree" and "1" representing "strongly disagree" (Table 2). Mean student responses were calculated for each descriptor.

RESULTS

Overall student satisfaction with the teaching module was positive (Table 1). Annual responses to the journal question indicated that the module impacted medical student attitudes in four important areas. Illustrative rather than comprehensive student quotations are reported to represent our outcomes.

First, educational contact and positive interactions with patients promoted the altruism that attracted these students to

Table 1. Freshman Evaluation of Breast Cancer Panel & Comparison to Other ICM Sessions in the Fall Semester.
(5-point scale, 5 = "strongly agree")

	Fall 2001		Fall 2000	
	BC Panel (n=110)	All Fall Sessions (n=2,303)	BC Panel (n=125)	All Fall Sessions (n=1,753)
Organization	4.58	4.33	4.56	4.18
Clarity	4.68	4.28	4.57	4.15
Enthusiasm	4.74	4.44	4.65	4.23
Knowledge	4.80	4.55	4.68	4.33
Rapport	4.65	4.38	4.56	4.19
Instructional skills	4.58	4.23	4.45	4.07
Professional characteristics	4.65	4.45	4.58	4.26
Overall excellence of instructor	4.73	4.37	4.64	4.20
Mean rating	**4.68**	**4.38**	**4.58**	**4.20**

There was no statistically significant difference between years.

medicine and helped the students understand the relevance of their academic work. "It is the attitudes of these 'survivors' that will make studying for gross and all other studies worth while and not seem like such a chore." "Cancer became more than a cell out of control; cancer was a tangible fear that disrupted and abruptly ended the life of many women." "Reading books and articles is helpful, but actually listening to people share their personal battles with cancer is much more real and will stay with me for a much longer time." "With all of the minor details that we are trying to learn it is very easy to lose sight of the real goal and that is to help people like them have a more enjoyable life."

Second, our findings support the research that suggests patient stories are powerful teaching tools.[11] Every panelist had a story that demonstrated the interaction between the biological, psychological and social aspects of a patient's life. "Well, I certainly learned a lot about breast cancer, but more than that, listening to each survivor tell her own unique story of her battle with the disease made me realize that every patient is going to be unique and real." "This was so much better than reading about the different stages of disease in a book. You cannot ask a book questions and get actual answers." "I think it truly helps us to see how much empathy and understanding mean to our patients and how much they value our time with them. It is important to know how our actions affect them." "I've thought about Mrs. B. every day since. She was rockin' cool." "I thought this session was great. I laughed and teared up and resolved to be a great communicator!"

Third, many young medical students have not emotionally experienced illness, suffering or death, nor have they confronted their feelings about cancer and the reality of there being disease that cannot be cured. "I've never had any serious medical problems, so I probably learned a lot more than some of the others in my class." "I never before heard someone share such intimate details about an illness that they have, and I was moved by their intense emotions." "I think it would have to be Mrs. H's statement when her doctor told her there was nothing new to try to treat her cancer ... I want to remember what she said because of the courage she showed in being able to accept it."

Fourth, these students understood the need for acquiring skills necessary for integrating social and behavioral concepts with biologic principles of patient care. Skills for providing comfort and healing, even in the absence of a cure, are important for humanistic patient care. "I hope I never forget to address the 'whole' person, instead of just focusing on the disease. Also, I hope to always listen to the patients since they know their body better than anyone else. As we continue our training, it may seem natural to distance ourselves from the human side of the patient, since we will be so caught up in diagnosis and treatment. I hope today's panel will help us to remember that these people are real." "I learned that all of these patients approached and dealt with their illnesses in a different manner, and that is precisely how it will be when I begin treating patients." "Mrs. B. reminded me that all people don't grow up like I did. She told us to remember that some people don't read. Some people don't know to get mammogram. Treat these people with the same respect you would treat others. I don't want to forget this so that I will be able to effectively take care of my patients."

A total of 19 senior students who had participated in the teaching module in the fall of 1998 responded to the follow-up survey (Table 2). The highest student ratings were reserved for integration of basic science concepts with clinical topics. Written comments expressed the feeling that the patient experience made a lasting impression. A majority

Table 2. Senior Student Evaluation of the Long Term Impact of the Breast Cancer Teaching Module.

Descriptor	Mean Student Response **(n=19)**
Connecting several basic science concepts with a clinical topic in a close time frame was a good way to teach me about breast cancer.	4.78
This interaction with patients enhanced my feelings of respect and compassion for patients with breast cancer.	4.68
The patient panel enabled me to understand the relevance of the basic science content.	4.32
This module was excellent preparation for clinical practice.	4.21
The breast cancer module motivated my interest in learning about the basic normal structure/function of the breast.	3.79

of senior student respondents mentioned that the death of one of the panelists, which occurred within a year of the panel discussion, had a strong influence on how they thought about patients and patient outcomes. One student stated that for him the take-home message was that "cancer patients are still people and that they should not be treated as third class citizens just because of their diagnosis." Another student wrote, "One of the women spoke about how her physician delivered the 'bad news' and how it affected her outlook, etc. That stuck with me - it was one of those comments that makes you want to slow down, take time with patients, explain things clearly, and add words of encouragement when appropriate."

DISCUSSION

Active, creative approaches in teaching improve student understanding of abstract ideas in the physical sciences.[12] Teaching students about the scientific aspects of breast cancer is a cognitive process, but teaching the psychosocial aspects of breast cancer requires experiences that stimulate learning in the affective domain. A study of breast cancer survivors by Harris and Templeton (2001) recommended that breast cancer patients and medical educators work together to improve communication skills of physicians. One of the strategies identified by the women in this study was patient panel discussions for medical students.[13] We believe that our experience validates the effectiveness of this teaching strategy. Consistent student responses to the journal question and anecdotal comments by the faculty over a three-year period, as well as the recall of senior students who responded to the follow-up survey, indicate that the panel discussion does impact students on an emotional level.

Although women with breast cancer have recently become more open about their disease and have taken a more active role in treatment decisions,[6,8] many breast cancer patients report that their psychosocial needs are not adequately addressed.[14] An important learning objective for this module was that medical students would be able to distinguish between a disease state and the illness experience. Objective and subjective student assessments indicate that we have been successful in making this distinction with our students.

Patient stories have been recommended as devices to help students acquire or change attitudes during medical education.[15] Medical decisions are based on the stories patients share with their physicians, and physicians use patient histories to convey information to other health care providers.[11,14] Every breast cancer patient has a unique story, and our study suggests that the stories the students hear early in their training remain with them throughout their medical education.

In conclusion, this format could be used to teach other clinical concepts and reinforce the integration of first-year basic science "facts" with clinical situations and patient stories early in the curriculum. This can be accomplished without a major alteration to the current curriculum, as long as all first-year and ICM course directors work in concert and schedule topic sequences appropriately.

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Teaching and Learning from the Community: The Development of a Student-Run Outreach Program

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ABSTRACT

For a group of first-year students at the University of Maryland School of Medicine, the statistics and trends indicative of the widening gap between the medical establishment and the Baltimore city population propelled them to create an outreach program, Baltimore Community Medical Outreach (BCMO). The purpose of the program is to empower city residents with the knowledge and consciousness required to establish contact with a health care provider as an initial step in addressing their medical needs. In its first year of operation, the group delivered a series of workshops at a local village center on a range of topics including HIV/AIDS, hepatitis, sexually transmitted diseases (STDs), hypertension, diabetes, and nutrition. The process of information dissemination, coupled with the audience's sharing of experiences, generated a collective knowledge that the audience could subsequently use to surmount the obstacles to patient-provider contact. The medical students learned many things in turn, including the transient holding power of medical advice, the need to tailor health guidelines to a specific population, and the many factors, such as family history of a disease, that drive a patient to action.

INTRODUCTION

Effective delivery of medical care is a process involving the intersection of two forces: one, adequate provision of resources and services by federal and private agencies, and two, patient initiative in utilizing such resources and services. Even if health care services are readily available, several forces may prevent a patient from accessing care. The routes of access may not be readily transparent, a patient may not embrace the value of health care, and systemic barriers such as poverty, homelessness, unemployment, and lack of insurance may further widen the gap between health care providers and consumers.

Such barriers to care are pronounced in indigent populations such as in Baltimore city. According to the U.S. Census Bureau, 22.9% of the Baltimore city population in 1999 was below poverty level (compared to 8.5% in the state of Maryland).[1] In the same year, the employment rate in Baltimore city was 7.1% (compared to 3.5% in the state of Maryland).[2] Though poverty and unemployment deprive persons of private or employer-based insurance, they may be eligible for such forms of public insurance as Medical Assistance and Children's Health Insurance Program. The potential of such programs, however, can be circumscribed by low patient uptake, due to unfamiliarity with the programs (including the processes of enrolling), or lack of concern for health. Homelessness and the co-morbidities of substance abuse and psychiatric disorders are further impediments to care, presenting circumstances that may relegate health to being a negligible issue, and disabling factors that may prevent patients from reaching a medical provider or complying with a medical regimen.

For a small group of students at the University of Maryland School of Medicine who shared a desire to find practical application of their growing medical knowledge, the alarming statistics propelled them to form an outreach program, Baltimore Community Medical Outreach (BCMO). The purpose of the program is to raise the health consciousness of Baltimore residents and bring them in closer proximity to medical care. The program first took shape as a more ambitious project of creating a free clinic, but with input provided by health professionals and community members, the group soon realized that patient-provider contact, while critical in initiating a continuity of care, is possible only after a requite series of obstacles are surmounted. Since health care is sought volitionally, patients must first have a fundamental understanding of health, as well as of the importance of services aimed at preventing, screening, diagnosing, or treating disease.

Using Carlo C. DiClemente's transtheoretical stages of behavioral change as a framework, we saw patient-provider contact as the "action" stage of change, reached only upon completion of the preceding stages of "precontemplation" (in which a person has no intention to change), "contemplation" (in which a person becomes aware of a problem and seriously considers overcoming it), and "preparation" (in which a person intends to take action in the near future and begins making small changes).[3] Realizing that as students, we could maximize our utility by helping patients progress through the initial stages of behavioral

change, we decided to make BCMO an outreach education program. Our goal would be to engage members of the Baltimore community in workshop discussions on various health issues, empowering them with the knowledge and facilities required to establish contact with health care providers as a first step in addressing their medical needs.

The function of BCMO is similar to what Brazilian educator Paulo Freire envisioned as "empowerment education," in which people would participate in group dialogue to create a collective knowledge, which in turn would allow them to determine their own needs and priorities, as well as strategies for overcoming their problems.[4] To Freire, "the health educator's role is to contribute information after the group raises its themes for mutual reflection. Rather than impose their own cultural values, educators should enter into 'authentic dialogue' so people emerge from their cultural silence and self-blame to redefine their own social reality."[4] Consistent with Freire's approach, BCMO fosters a two-way learning process in which we, as health educators, enlighten members of the Baltimore community on health issues, while they, in turn, illuminate for us the circumstances, values, and cultural norms that comprise an often overlooked dimension that has strong bearing on how they respond to a disease or to a prescribed course of medical therapy. By allowing the audience to assimilate health information and their experiences in dealing with a disease, the reciprocal learning process generates a collective knowledge that can be used as a pivotal force in progressing through the stages of behavioral change, ultimately leading to contact with the health care establishment, or increased competency in working with health care providers to optimize plans of care.

MATERIALS AND METHODS

One of our primary research tools were a series of panel discussions in which we invited health professionals and community members to share views on how we could best serve the Baltimore community. In the first panel, focused on identifying the possible utility and niche of a student-run free clinic, panelists brought the project one step back by suggesting that a free clinic was not the best means of helping the Baltimore community. "The problem isn't a lack of services," one panelist mentioned, "but that patients aren't utilizing them." Another panelist described health care for the poor as "a web of patched-together services that has the tendency to fall apart." Instead of adding another provider site that would make the rugged terrain of the health care system even more difficult to navigate, the panelist suggested that we help patients develop confidence in working with the existing facets of the health care system. We could teach them such basic skills as applying for insurance, choosing a provider, assembling a medical history, and devising a schedule to optimize compliance to a medical regimen.

Another panel discussion on the subject of HIV/AIDS, a disease for which an extensive range of services exist, served as a testing ground for the theory that the problem is one of underutilization of existing resources. "What we have to understand is that it's more important to move people closer to understanding and accepting care rather than prematurely rushing them into it," a panelist remarked. The problem is not systemic in that there is a dearth of HIV clinics or testing sites, but rather, exists as a patient's own barriers to being tested or seeking treatment for HIV. Rather than duplicating existing services and not address the intrinsic problem relating to their underutilization, we could help individual patients understand the importance of being tested or treated for HIV, thereby increase their likelihood of utilizing available services. A free clinic was no longer in our plans, since it would misdirect the faculties that we, as medical students, were uniquely in possession of, namely, the ability and willingness to take time to listen to patients. We decided that the best way to help the Baltimore community was to educate them, empowering them with health knowledge and the drive and capacity to work with existing facets of health care system to promote their health.

West Baltimore is divided into "empowerment zones," each allocated funding from the city government, and each with its own village center acting as a central point from which patients can be channeled into various avenues of support, from back-to-work programs to drug rehabilitation services to assistance in obtaining medical insurance. Each month, directors of the village centers meet with representatives of the university and its professional schools to discuss ways by which students and university-operated programs could direct their professional skills to the activities of the village centers. Our attendance paid off when we were invited to deliver a workshop at one of the local village centers, which we decided to focus on the subject of HIV/AIDS.

In preparation for each workshop, we prepared a reference booklet highlighting important points regarding the etiology, presentation, diagnosis, treatment, prognosis, and prevention of a disease. Though we assembled the booklets using resources directed at medical professionals (internet sites, journals, and textbooks), the booklets were written at a level appropriate for the attendees. We would use laymen terms to explain, for example, the biochemistry underlying viral replication and infectivity, or the physiology underlying the end-organ diseases of chronic hypertension. The reference booklets not only served as a discussion tool for the audience, but, in their assembly, helped us to acquire a fluency and expertise in the topic of discussion. The reference booklets also gave durability to the salient points of our discussion (beyond the hour-and-half we were granted per workshop), allowing the audience to deliberate further on certain issues after the end of a workshop. Furthermore, the attendees could partake in the process of information dissemination by distributing the reference booklets to family, friends, and acquaintances.

The outreach program has been in operation for two years. Funding for the program, which comes from the student council, is used to cover administrative costs and printing costs of the reference booklets. The program is staffed each year by a small but dedicated group of first- and second-year students. Since the rigors of the clerkship years limit

participation to the freshman and sophomore classes, there is frequent staff turnover, but the transition is made smooth each year by having the rising sophomores take over reigns of the operation well before the rising juniors are shuttled off to the wards. While there is consistency in the schedule of the workshops (being held on the first Tuesday of each month), exam periods are more sporadic, and sometimes problematic in distracting from the preparative stages of the workshops. The problem is minimized by having first-year students take lead role in preparing a workshop when the second-year class is burdened with an exam, and vice versa.

The topics covered in the monthly workshops have included other infectious diseases such as hepatitis and sexually transmitted diseases (STDs); metabolic diseases such as hypertension, dyslipidemia, and diabetes; lifestyle factors such as substance abuse and nutrition; and diseases to which African-Americans (the majority of the audience) are predisposed, including sickle cell disease and certain cancers. Each topic presented us with a unique teaching opportunity, as well as a chance for the audience to impress us with their "street knowledge" on the topics of discussion, or to share their experiences in dealing with a disease.

RESULTS

HIV/AIDS

We opened our first workshop with a question, "Can anyone tell us what the difference is between HIV and AIDS?" The answers came without delay. The audience fused together their shards of knowledge into a compendium that closely approximated what we, as trained semi-professionals, were able to convey. Though they harbored certain misconceptions or "myths" regarding the disease (such as one about Magic Johnson having been cured of AIDS), and sometimes drew rebuttals from us, they were never discouraged from sharing more.

To add to the utility of the reference booklet, we included an appendix listing the various sites at which HIV testing was offered, making sure to distinguish between testing that was confidential (only the patient and medical personnel would know the result) and testing that was anonymous (only the patient would know). For patients who had absolutely no access to clean needles and couldn't resist the urge to use, we included - as a measure of last resort - a section on how to "clean works," a process by which cold water and bleach could be used to wash needles and thus minimize transmission of disease.

Near the end of the workshop, one attendee raised his hand. "It's easy for medical students and doctors to stand up there and tell us that we shouldn't practice unsafe sex, and it's easy for us to believe you. It's a whole different matter when any of us - any of us sitting here, any of you standing up there - are there in the heat of the moment, and there's other things on our minds than this one piece of advice that we've heard a million times before." The comment, echoed in various ways in ensuing workshops, spoke about the differential weight that medical advice carries in the doctor's office versus real-life situations. The comment also spoke about the non-discriminatory nature of the disease, suggesting that we, like anyone else in the room, could chronically ignore a simple piece of medical advice.

The end of the session brought many thanks from the audience, as well as an invitation to return to deliver workshops on a monthly basis. Debriefing on the ride home, we reeled from the excitement of knowing that our debut had secured us a continued presence at the village center, opening up a realm of possibilities in influencing these people's lives. The clearest indicator of our success was the active interchange that took place, one that had re-ignited a dormant passion in the audience to speak about and care for their health. Our goals for that evening had been set in accordance with what the panelists suggested. We wanted to bring the patients closer to the point of accepting care, a milestone marked by an increased willingness to undergo HIV testing or treatment. If any such change has been made, we may never know.

Hepatitis

In a subsequent workshop on infectious hepatitis, we were presented a threefold challenge in that instead of talking about one virus, we had to talk about three - hepatitis A, B, and C. We opted for an approach similar to that of our professors in comparing the viruses along such parameters as viral type, clinical presentation, diagnosis, treatment, and prevention. At the end of the workshop, we quizzed the audience on what they had learned, not at all surprised when they scored perfectly on all questions. Though the interchange had chilling resemblance to what many students see as the bane of the pre-clinical years - route memorization and regurgitation - the audience proved that it could assimilate a wealth of information. At the following workshop, one of the attendees raised his hand and said, "I gave the booklet on hepatitis to a friend who I thought could use it. Two days ago, he calls me up and tells me he's starting treatment for his hepatitis." Our jaws dropped. This was an unmistakable sign of victory, clear evidence that our influences had reached beyond the village center, with members of the audience working on our behalf. They were doing for others what we did for them.

STDs

In our workshop on STDs - inclusive of chlamydia, gonorrhea, genital herpes, and syphilis - we had the scare tactic working for us. The mere description of symptoms would cause the audience to reflexively grasp their viral organs. The statement, "Have unprotected sex and this is what will happen to you," was implicitly made throughout the night. The workshop had more immediate impact than the previous two, probably due to the invariable connection between the disease and its methods of contraction. The audience was also treated to a crash course on anatomy, since an understanding of the complications of STDs – including epididymitis, prostatitis, cervicitis, and salpingitis – required familiarity with the anatomy of the reproductive organs.

Hypertension

For the next workshop on hypertension, the audience walked into the village center to see medical students armed with blood pressure cuffs and stethoscopes. They rolled up their sleeves and sat down for the verdict. Many were aware of their high blood pressure, and our measurements served to remind them of how long they've allowed the problem to fester. When asked about diet and exercise, their meager responses indicated that they knew their lack of initiative was partly to blame. In previous workshops, the audience had been reluctant to share their personal experiences of a disease (probably due to the nature of the disease under discussion), but with the topic of hypertension, those inhibitions were suddenly lifted, especially among those who were African-American and thus understood their disposition to the disease. We became privy to stories about endless trips to the bathroom that came with taking diuretics, or the cosmetic terror of watching one's face swell up from taking ACE (angiotensin-converting enzyme) inhibitors. One man made a stout refusal to take any medications because they dampened his sexual performance. His comment was echoed by many other men in the group, who thanked him for broaching a topic that they often didn't have the courage to discuss. The audience bonded over the universality of their disease, finding a communal voice that clamored about a medical burden that was written into their fate by the laws of heredity and aging.

Nutrition

The workshop on nutrition was refreshingly different in that we didn't discuss a disease, but a lifestyle factor that many in the audience had the capacity to change. We began by suggesting that 2,000 calories was a reasonable daily intake that, when balanced against caloric expenditure, would allow a person to maintain or lose weight. We then proved with a simple demonstration of calorie counting that an extra value meal at McDonald's could alone account for those 2,000 calories. On talking about foods that were particularly unhealthy, the audience moaned as we listed some of their favorite dishes. When we told them there was one food in particular they should avoid, given its high content of salt and fat, they begged us to go no further, since they knew the food in mention was fried chicken, a dish they were reluctant to part with. Not having much foresight into the diet with which the audience had been born and bred, we didn't realize how unrealistic our recommended diet sounded. The glimmer in the audiences' eyes when certain foods were mentioned proved to us that priorities were different. Perhaps the seriousness of the preceding workshops made the audience see this one as a respite. The audience wasn't ready to change, and remaining true to the lessons learned from the panelists, we didn't push it any further.

Diabetes

The final workshop of the first year of the outreach program was on diabetes. The rising sophomores had assumed full responsibility in preparing the workshop, bringing the cycle in full swing and landing them exactly where we had been nearly one year ago. Though each successive workshop had drawn increased participation from the audience, the audience was disproportionately outspoken on the subject of diabetes. As with hypertension, enough members of the audience could lay claim to the disease, as well as its ensuing burdens - the painstaking regimen of oral medications or insulin injections, as well as the necessity of regularly checking their blood glucose levels. With diabetes, however, many in the audience had witnessed the wrath of the disease, having seen friends or family members lose a foot, an entire leg, or even their vision as a result of not keeping their sugar under control. The tragedies hit close to home, enough to scare the audience into an unwavering loyalty to their medications and glucose checks.

One attendee, who usually remained quiet during the workshops, moved into the front row and pulled out a glucometer. "I had trouble sticking with my medications at first. I didn't see why it was important to take them every day. Even when my doctor told me my sugar levels were sky high, I still had trouble remembering to take the pills, since there was nothing to remind me, nothing to give me a concrete reason for taking the pills three times a day. My doctor suggested that I get one of these, so I could measure my sugar every day. And that's when I began to stick with my medications, not because my levels were sky high, but because I was now in control. I didn't have to wait to see my doctor to get my levels checked. I could do it on my own, and I could see for myself what my medication was doing. For some of us, this is what we need. Once we have it, the road's a little easier."

DISCUSSION

After the first year of our outreach program, it was clear that BCMO had found a place in the Baltimore community. Our purpose and utility to the community had been clearly delineated as helping residents become more conscious and appreciative of their health, an impetus for establishing contact with medical providers and utilizing services offered by the medical community. Our efforts had been validated in several ways, as by the enthusiastic response of our audience, their regular attendance at the workshops, and our continued presence at the village center (and expansion into others) two years into our operation.

One of the goals of our outreach program was to help the audience overcome the decisional barriers that kept them from establishing an interface with the medical community. The clearest indicator of our success was that a friend of an attendee, having been given the reference booklet on hepatitis, finally sought treatment for his hepatitis. In the workshop on HIV/AIDS, the audience's knowledge on the subject and their inquiries into treatment options indicated that they were weighing the pros and cons of being tested for or seeking treatment for the disease. For the diseases that were highly prevalent among the audience - hypertension and diabetes - many in the audience were already undergoing medical treatment. With the interface already established, their task was to work with doctors to optimize their medical regimen, and to sustain their commitment to avert further progression of the disease. Though they were

reluctant to yield to our dietary advice in the nutrition workshop, the audience's recognition of the health risks associated with certain components of their diet suggested that they had the knowledge base required to make informed decisions once they were ready to change their diet.

In accordance with Freire's suggestions, we engaged the audience in an "authentic dialogue" to illuminate their cultural values and allow them to arrive at a collective knowledge based on the sharing of experiences. On the subject of nutrition, we realized that the audience ascribed a certain value to food that made it difficult for them to give up certain dishes for the benefit of their health. The complaints that many in the audience lodged against antihypertensives, because of such adverse effects as angioedema or impotence, indicated that issues pertaining to quality of life sometimes outweighed the clinical benefits of pharmacological treatment. Since hypertension and diabetes were well ingrained in their family lineages, the audience already had a collective knowledge on those subjects. The audience, true to Freire's theories on empowerment education, used that collective knowledge to develop strategies for addressing the problems, as exemplified by their strict adherence to diabetic medications and glucose monitoring.

The audience also made us realize how the impact of medical advice can abate from the time it was delivered in a medical setting to the time (or circumstance) in which the advice would be most utilizable. As one attendee mentioned, the reasons behind a physicians' advice not to engage in unprotected sex are well understood, though the task of adhering to such advice "in the heat of the moment" can be difficult. The nutrition workshop reinforced the importance of tailoring health guidelines to a target audience to maximize their feasibility. The diet we promoted had been largely derived from health guidelines directed at a general audience, assuming no differences in baseline diets and thus no discrepancy in how easy it would be to transition to the recommended diet, an oversight we are sure to avoid in the future.

As medical students, we know we've mastered a concept when we're able to teach it to someone else. In the wards, the process of learning a procedure is to "see one, do one, teach one." By the end of the first year of our crusade, we all had become teachers. In delivering the workshops, we had taken our medical knowledge and taught it to others, tailoring it to our audience as much as our professors had done for us. One attendee was a teacher when he helped his friend seek treatment for hepatitis. Others in the audience had taught us the best ways they've found to manage their diabetes. Listening to the audience that night, I realized that as teachers, their eloquence far surpassed our own. They knew as much about a disease as we were able to teach, yet on top of that were many years of pure experience that made them inspiring spokespersons for the disease. If doctors are truly defined by the origin of their name, *docēre*, meaning "teacher," then the clients of the village center certainly met the requisites for the profession. That night, they were the true "doctors" in attendance.

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Association of Remedial Tutorial to Students at Risk of Failing Anatomy and Their Improved Performance

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ABSTRACT

The purpose of this study is to evaluate the effectiveness of a structured, interactive remedial tutorial intervention program for at risk students. During the period studied, between 10 and 20% of the first year students failed the unit 1 gross and developmental anatomy examination. These students were provided with a highly structured series of weekly interactive remedial tutorials (3-4 hours each for 13 weeks) that specifically involved the application of factual knowledge to clinical problem solving. Their performances on subsequent departmental and National Board of Medical Examiners (NBME) subject examinations were evaluated. By developing a remedial tutorial program in an interactive small group format with specific goals the at-risk students built confidence and acquired the cognitive ability to solve clinical problems. As a result, they successfully completed the anatomy course. Data collected from the last five years firmly supports the concept that, independent of a student's prior experience, consistent practice with problem solving enables successful completion of the first year course.

INTRODUCTION

In 1984, the Association of American Medical Colleges (AAMC) recommended curriculum changes at all traditional medical schools toward problem-based, student-centered learning with an integration of basic and clinical sciences.[1, 2] Preclinical curricula in medical schools across the country have continued to move away from the teacher-centered and discipline-based curriculum to an integrated student-centered model. The changes involved reduction in lecture hours (learning discrete facts) with more emphasis on teaching concepts and principles to help students develop problem-solving skills.

The Gross and Developmental Anatomy course at New Jersey Medical School (NJMS) is a highly clinically correlated course. Thus, students need basic cognitive skills in knowledge acquisition and interpretation, coupled with problem identification and clinical reasoning to perform well. Students enter our first-year, first-semester course with a variable range of problem solving skills. When confronted with a rigorous course in anatomy during the early part of medical school, the task of acquiring a highly detailed knowledge base is often a challenge. The ability to apply this information during analysis of clinical problems also varies among students. In gross and developmental anatomy, students are no longer assessed on their ability to recall isolated pieces of information. Instead, examinations include objective and structured multiple choice questions (MCQ) with clinical vignettes that are designed to test problem-solving skills. The purpose of this study is to evaluate the effectiveness of a structured, interactive remedial tutorial intervention program on subsequent performances of at-risk students in the gross anatomy course. Specifically, a performance-based method that is used in the gross anatomy course at NJMS is described.

MATERIALS AND METHODS

The study involved students who failed their first unit written anatomy examination, which was given five-weeks into the course. Students who received scores below the passing grade of 70% were considered to be 'at-risk'. Approximately 65 % of the course time was spent in cadaver dissection with four students assigned to each cadaver. The laboratory instructors routinely stressed clinical application of anatomical knowledge, and attendance in the laboratory was mandatory. The course was taught by ten experienced faculty and the information presented was uniform in each laboratory. In addition to anatomy, students concurrently studied physiology and psychiatry and two one-half day periods were available each week for unstructured activity. Table 1 serves to summarize content and time allotted for each unit of the gross anatomy course. The developmental anatomy material that pertained to each unit was presented during structured, clinically oriented lectures, and this material was included in the written examinations. The average GPA and MCAT scores were comparable for the classes (GPA 3.48 $\pm$ 0.06; MCAT 30.05 $\pm$ 0.4) evaluated in this study.

At the end of each unit, students were required to take a practical laboratory examination and a written examination that consisted of multiple-choice questions (MCQ). Each unit

Table 1. Content and time allotted for each unit of the course.

	Unit 1	Unit 2	Unit 3
Content	Thorax Back Upper extremity	Head Neck	Abdomen Pelvis Perineum Lower extremity
Allotted time	5 weeks	4 weeks	6 weeks
Course hours	73	49	57

written examination typically contained 120 MCQ's. A major proportion of the questions were in the form of clinical vignettes that were developed for the content of each unit (Appendix 1). The time allotted to complete each unit written examination was 2 hours and 30 minutes. Students were not permitted to keep the examination booklets, but were allowed to review the questions in a supervised setting after their grades were posted. For each unit practical examination, students were required to identify 50 structures on the cadaver. The NBME subject examination was used as a comprehensive final.

Each student who failed the unit-1 written examination received a letter directing them to attend a structured tutorial program. All students, considered at-risk, attended these tutorial sessions, which were interactive and based on problem solving. Prior to such structured tutorial sessions (before 1997), students who failed the unit-1 examination were tutored either by the graduate students or upper class medical students. These tutorials were arranged through the Office of the Academic Development, and the anatomy department played no role in directing the tutors.

The structured tutorial program consisted of one, 2-3 hour session each week for the remainder of the semester. An additional hour of tutorial was conducted in the laboratory. Students were required to study the weekly material prior to each tutorial session and during the tutorial, they were taught to apply this knowledge to analyzing and solving clinical problems. By requiring student preparation before each session, a sense of shared responsibility between the students and faculty was established. During the past three-years, problems discussed during these interactive sessions have included pathophysiology to expand the students' thinking process. We also incorporated MCQ's that tested basic anatomical knowledge.

During each session, approximately 10-15 problems were discussed in an interactive format (Appendix 2). The author facilitated these interactive sessions and ensured active participation by all the students. 'Backward' reasoning, i.e. working from clinical information back to theory when problem solving, sharpened their analytical skills. Students' performances on units-2 and units-3 and the NBME subject examination were evaluated to test the benefit of the structured tutorial sessions.

RESULTS AND DISCUSSION

The premise for this study was that early identification of first year students who were at risk of failing gross anatomy provided a basis for intervention with remedial tutorial programs. We hypothesized that failure of the first gross anatomy examination, given five-weeks into the program, was

Table 2. Number of students who scored below the passing grade in each unit examination.

Year	% of Clinical Questions	Unit 1	Unit 2	Unit 3	Final	Course*
1997 (S)	25	7	1	31	57	4
1998 (S)	45	14	4	19	29	2
1999 (S)	75	33	8	15	6	4
1999 (F)	90	35	8	13	7	6
2000 (F)	90	35	11	7	1	3

S= Spring & F= Fall semester. Passing grade = 70. Final = NBME subject examination.
* Number of students who failed the course, and their status are shown below.

Year	Left the school	Repeated the year	Passed summer examination
1997 (S)	1	2	1
1998 (S)	-	1	1
1999 (S)	2	11	
1999 (F)	-	4	2
2000 (F)	-	2	1

Table 3. Class performance- average grade for the Academic year 1997 through 2000.

Academic Year	% of clinical questions		Grade in Percent*			
		Unit 1	Unit 2	Unit 3	Class course average	NBME
1997	25	85±8.2	82±6.4	79±9.7	82±8.1	73±6.8
1998	45	80±8.2	84±6.8	77±8.8	81±7.9	77±7.3
1999 (S)	75	78±9.0	84±6.8	79±7.4	80±7.9	81±7.0
1999 (F)	90	77±9.8	85±7.5	85±7.5	82±8.3	84±7.9
2000 (F)	90	76±9.5	82±8.9	82±9.1	80±9.2	83±6.5

* Indicates class average for the unit examination. Class course average: Indicates aggregated class course average for the year. NBME: Examination score provided by the NBME.

a reasonable warning of further academic difficulty. The class size for each academic year included in the study was between 171-176 students. In 1997, seven students (4% of the class) failed the unit-1 examination. However, while most (6.5%) improved their test score on unit-2, four students (more than half the students who were considered at risk) failed the course. In 1998, fourteen students (8% of the class) failed the unit-1 examination. Ten of them improved their performance on the unit-2 examination, and two of the original 14 failed the course. In years 1999 and 2000, 20% of the class (35 students) failed the unit-1 examination, which was greater than the previous years. Following the tutorial, approximately 65-75% of the failing students, improved their performance in units-2 and unit-3 and scored above the passing grade.

The number of students failing the unit-1 examination increased steadily from 4% in 1997 to 20% in the year 1999 and 2000. As shown in Table 2, proportions of the MCQ with clinical vignettes also increased from 25% in 1997 to 90% in 2000. These clinical questions required analytical interpretation and problem solving. In the Fall 2000 course only seven of the 35 students who failed the unit-1 examination did not show improvement on subsequent examinations. Table 2 indicates that more students performed poorly on unit-3 than the unit-2 examination. During the last few weeks of the anatomy course, the students also took final examinations in other concurrent courses, and this seemed to adversely affect their performance in anatomy.

Average grades for the course's unit examinations are shown in Table 3. The class average for unit-1 steadily decreased from 85% in 1997 to 76% in 2000. On the contrary, the class average for unit-3 examination showed an improved performance during the same years. When the proportion of clinical questions was increased in the unit-1 examination, the number of students who failed this unit was also increased. However, after the students were assisted in learning to apply factual information to the clinically correlated questions in the subsequent 13-weeks of the course, their performances on unit-2 and unit-3 were improved. Moreover, incorporation of clinical correlations in the day-to-day teaching and in the unit examinations substantially increased the performances of all students on the NBME subject test, which served as the comprehensive final (Table 3).

In the last five classes three students left the medical school while eight students, due to multiple subject failures, repeated the first year (Table 3). Those students who had failed only anatomy was given a NBME subject test as make up summer examination. All students who took the make up examination passed and were promoted to the second year.

Table 4 presents average grades for the course's unit and final examinations for the students who failed the course, prior to instituting the remedial tutorial program. I contend that had there been a remedial tutorial program, most of these students would have successfully completed the course. In support of this contention, I would suggest that the tutorial program, as indicated by students in the course evaluation, helped to redirect the learning approach, that is, applying discrete facts to problem solving encouraged the students to synthesize and integrate anatomical concepts. Secondly, the interactive nature of the tutorials enabled open discussion among the students that resulted in collective thinking to reach the right answer, and thereby solve the problem posed. During the fall semester of 2002, the tutorial program was discontinued, and the students worked extra hours on their own. This self-directed approach resulted in 11 failures for the course. Of the 11 failing students, at least seven could have been helped had there been a tutorial program. Looking at the data from 1995 and 1996, which were pre-tutorial, and the data from 2002, when the tutorial was discontinued, I strongly feel that the tutorial program was helpful in redirecting the students approach to learning, which then led to their success in the course.

CONCLUSION

Students at-risk for failing gross anatomy, when placed in a structured remedial tutorial program, were successful in ultimately passing the course. The key to this success was initially delegating the responsibility of learning to the students and subsequently facilitating the interactive group process where gained knowledge was applied to clinical problem solving.

Table 4. Course performance of students who failed Gross Anatomy prior to instituting the tutorial program.

STUDENT	UNIT 1	UNIT 2	UNIT 3	FINAL
Academic year: 1995				
1.	57	64	56	63
2.	61	65	53	63
3.	66	58	66	61
4.	55	49	51	48
5.	63	57	69	63
6.	65	56	65	60
7.	64	63	63	66
8.	49	55	57	60
9.	60	66	61	62
10.	55	51	60	49
11.	63	59	48	63
12.	60	54	63	62
13.	66	52	62	62
14.	63	59	43	62
Academic Year 1996				
1	65	59	60	69
2	43	50	50	46
3	63	47	60	60
4	65	63	64	68
5	63	64	64	55
6	63	57	61	67
7	63	60	64	71
8	65	63	61	65
9	58	59	64	64
10	62	65	59	61
11	58	62	58	68
12	53	49	51	62

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APPENDIX 1

Questions used in MCQ's

CASE (1): A patient complained of tiring easily, and shortness of breath on exertion. Auscultation of the chest showed a diastolic heart murmur heard best at the apex of the heart, and the presence of a collapsing pulse (forcible pulse that rapidly diminishes).

Question: In the above patient, which one of the following conditions explains the 'collapsing pulse'?

A. Disease of the tricuspid valves.
B. Disease of the bicuspid valves.
C. Aortic insufficiency.
D. Coarctation of the aorta.
E. SA node problem.

Answer: C

CASE (2): After minimal exertion a 10-year-old child complains of tiring easily and shortness of breath (SOB). Auscultation of the chest showed a continuous machinery like murmur left of the sternum between the first and second intercostal space. At the time of SOB, analysis of the arterial blood oxygen level is slightly elevated in the right radial artery compared to that sampled from the left femoral artery. Chest X-ray showed a dilated pulmonary artery.

Question: Which one of the following conditions explains the child's problem?

A. Patent ductus arteriosus.
B. Patent foramen ovale.
C. Pulmonary artery stenosis.
D. Aortic valve stenosis.
E. Coarctation of the aorta.

Answer: A

APPENDIX 2

Interactive tutorial sessions

CASE (1): A 27- year-old female complains of progressively worsening shortness of breadth while playing tennis.

History of present illness: Increasingly fatigue over the past several months with recurring palpitation (what is it?).

Physical exam: Heart rate 130 (Is this normal ? If not, Clinically, what is it called?), BP 85/58 (Is this normal? If not, Clinically, what is it called?), No Cyanosis (What is it?), left parasternal heave (Why?), mid-systolic ejection murmur in the pulmonary area, (Why?), unusually louder mid-diastolic rumble heard in the 4th ICS at the left sternal border (Why?), systolic flow murmur at lower left sternal border.

Labs: Right ventricular hypertrophy (RVH), increased oxygen saturation between the SVC and right ventricle.

Imaging: Increased pulmonary vascularity (Why?), dilated pulmonary artery (Why?), Right atrium and ventricle enlarged (Why?), small aortic knob (Why?).

What is your diagnosis? (Atrial Septal Defect)

Answer all the questions.

CASE (2): A 29-year-old male complains of fatigue easily, persistent headache and epistaxis (What is it?).

History of present illness: Dyspnea on exertion, palpitation, claudication (What is it?) and occasional dizziness.

Physical exam: Normal respiratory rate (how many?), BP in arms 195/90, leg 90/65, delayed and weak femoral pulse compared to radial pulse. (Why?), no cyanosis. Chest exam- harsh, late systolic ejection murmur heard in the interscapular area of the back , bilateral palpable intercostal pulse (Why?).

Labs & Imaging: Chest X-ray- suggests LVH (Why?), rib notching (Why?), enlarged aortic knob (Why?).

What is your diagnosis? (Coarctation of the aorta)

Also answer all the questions.

Introducing Critical Appraisal of Biomedical Literature to First-year Medical Students in Histology

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ABSTRACT

During the preclinical phase of medical school, most students rely on instructor-provided lecture notes and required textbooks, and note taking during lectures. By the time medical students begin their clinical clerkships, they are accustomed to accepting the word of authority at face value. Paradoxically, physicians must be able to critically evaluate and solve patient problems from a rapidly expanding body of biomedical literature. To address this discrepancy and to help show the relevance of histology to medicine, we implemented a program to introduce critical reading of biomedical literature throughout our 21-week histology course. During weeks one through four, students in the class of 2003 (N = 224) were randomly divided into 56 groups (n = 4) and taught how to conduct a MEDLINE search. Groups were required to submit a biomedical publication abstract from their MEDLINE search that contained histological and clinical elements by week eight. Subsequently, students attended two 60-minute critical appraisal seminars. By week 15, groups submitted a one-page summary of their selected journal publication and answered a set of critical appraisal questions. During weeks 16-19, students prepared a four-minute oral presentation. Three years later, these students were asked to assess the value of our critical appraisal program. Most respondents agreed and strongly agreed (96.1%) that the time needed to complete Critical Appraisal program was manageable. Nearly three-quarters of the respondents (74.5%) agreed and strongly agreed that the Critical Appraisal program demonstrated the relevance of histology to medicine, helped in other courses, and fostered collegiality among classmates. More than fourth-fifths of respondents (86.3%) agreed and strongly agreed that the Critical appraisal program was worth the effort. The critical appraisal program described herein is a resource-efficient method for introducing critical appraisal of biomedical literature to first-year medical students within the context of a first-year basic science course.

INTRODUCTION

As a result of biomedical research and technological advancement, physicians are continuously inundated with new information about preventive measures, diagnostic tests and treatments that will improve the quality of patient care. Consequently, physicians need to be able to critically evaluate the soundness and application of medical research studies in order to distinguish between beneficial preventive, therapeutic, and rehabilitative procedures from those that waste time and money, and may cause more harm then good.[1] A buzzword in medical education that describes the use of contemporary evidence for making patient care decisions is evidence-based medicine (EBM).[2]

EBM consists of being able to devise questions from clinical problems, finding and evaluating high quality, relevant evidence from the literature, and solving clinical problems with the most current information.[3] The life-long practice of EBM, including critical appraisal is a self-directed process that many medical practitioners have either limited or no formal education in research and are not adequately prepared to critically analyze the quality of research they are reading.[4] More than 50% of medical school graduates report inadequate training in evaluating the methodological quality (i.e., critical appraisal) of biomedical literature.[5] Specific educational interventions targeting critical appraisal skills are prerequisite for medical students to become effective practitioners of EBM.[6]

The teaching of critical appraisal, a major component of EBM has been increasingly integrated into all levels of medical school curricula.[7] Several studies have described the teaching of critical appraisal and/or other components of EBM to first-year medical students. Riegelman[8] described sixteen-hour, required course at George Washington University School of Medicine, teaching first-year students how to review different types of studies (e.g., prospective studies and controlled clinical trials) and how to apply these data to clinical practice. Results from this study showed that the pre-clinical course in study design and statistics positively affected students' perceptions of their knowledge

Table 1. Critical Appraisal Project Timeline.

Histology Course (weeks)	Critical Appraisal Program Procedures
1-4	• MEDLINE instruction provided • Biomedical publication selected
5-7	• Abstract from biomedical publication submitted for instructor approval (Table 2)
8-12	• Two 60-minute critical appraisal seminars given
13-14	• Set of critical appraisal questions answered (Fig. 1) • One-page summary written (Fig. 2)
15	• Answers to critical appraisal questions and one-page summary submitted for instructor critique
16-19	• One-page summary revised (Fig. 3) • Oral presentations prepared
20-21	• Oral presentations given (Fig. 5)

of study design and basic statistics. However, the author concluded that the effects of this preclinical course would be ineffective without opportunities for reinforcement in the clinical years.

Stacpoole and coworkers[9] reported teaching "hypothesis-oriented thinking" to first-year medical students. The authors indicate that clinical diagnosis is a "hypothesis-guided process" in which a patent states a chief complaint, and the physician formulates a set of diagnostic hypotheses that are tested during the history, physical examination and choice of laboratory tests. The entire freshman class served as either study subjects or investigators for hypothesis-driven experimental investigations in a clinical setting. Students' survey responses of the research program indicated that most considered the hypothesis-driven program to be useful and relevant to their overall education.

Recently, Malathi and colleagues[7] described an eight-hour EBM course taught to first-year medical students. This program developed from a recommendation by third-year students to introduce EBM material before starting clinical rotations. Student satisfaction surveys and a faculty questionnaire indicated that both the students and the faculty were satisfied with the EBM course, and that the introduction of clinically relevant EBM material to first-year students was practical, feasible, and desirable.

A pilot program in which a "motivated" senior medical student designed and taught EBM and other clinically-focused topics (e.g., physical examination skills) to first-year medical students was recently reported by Josephson and Whelan.[10] The 16-hour, selective course was evaluated favorably by the first-year students, the fourth-year instructor and a faculty advisor. The authors concluded that the course filled an existing need in the first-year curriculum and that the program could be incorporated into diverse academic settings.

Published studies suggest that EBM, including critical appraisal is predominantly taught during the clinical years of medical school.[7] Dorsch and coworkers[11] reported using a multidisciplinary approach for teaching third-year medical students information retrieval and critical appraisal. The ten-week course consisted of medical faculty providing instruction in reading and evaluating research methodology, whereas the library faculty taught online literature searching. Based on formal evaluation and informal feedback, the course showed how the literature search was integral to the critical appraisal of medical literature and the clinical decision-making process.

The effects of two 90-minute interactive seminars on third-year medical students' knowledge of research design, basic critical appraisal skills and attitudes toward the clinical use of medical literature was examined by Landry and colleagues.[12] Third-year students receiving the intervention were more likely to consider study design important in article selection and use of medical literature critical to patient care decisions compared to the 81 third-year control students. Moreover, the study group did show a significant increase in knowledge of critical appraisal. However, the two seminars did not increase use of medical literature in patient write-ups.

A case study by Fikree and Marsh[13] reported that the Department of Community Health Sciences of Aga Khan University Medical College taught critical reading of research to third-year students. The first two weeks of the program consisted of three one-hour classroom sessions and four one-hour small group sessions. Thereafter, small groups met monthly to review clinical epidemiological reports. A student questionnaire indicated that all students agreed that critical reading skills were essential, but only 30% strongly agreed that they had mastered the skills. Ninety-seven percent of the students disagreed that year three was too early to start critical reading.

How critical appraisal is taught to medical students during an obstetrics and gynecology rotation was described by Grimes and colleagues.[14] A series of seminars were given to foster critical reading of the literature and evidence-based ward rounds were used to provide practical application of critical appraisal skills. Although, the authors did not have a quantitative assessment of their approach, they indicated student feedback was enthusiastic.

Table 2. Biomedical Publication Titles.

Group Number	Topics
1	Glutathione peroxidase expression/ myocardial ischemia reperfusion injuries
2	Classification systems for curatively resected colorectal adenocarcinoma
3	Alpha-1 antitrypsin deficiency
4	Ultrastructure of airway epithelial cell membranes among patients with cystic fibrosis
5	Hepatic stellate cells in veno-occlusive disease of the liver
6	Aminoguanidine inhibition of autoimmune encephalomyelitis
7	Transplantability of bone marrow-derived mesenchymal cells
8	Intraoperative frozen section/ imprint cytological investigation / sentinal lymph nodes
9	Apoptosis /associated with atypical or malignant change in meningiomas
10	Sex-related differences in bronchial epithelial changes associated with tobacco smoking
11	Myofibroblasts. Paracrine cells important in health and disease
12	Apoptosis/expression in salivary gland tumors
13	Histology and electron microscopy of explanted bifurcated endovascular aortic grafts
14	Diagnosis of Pneumocystis carinii pneumonia/ monoclonal antibodies
15	Effects of parenterally administered triazolam on sleep in rats with preoptic area lesions
16	Asymmetry of cilia and of mice and men
17	Interleukin-1/ tumor necrosis factor/ wound strength
18	Apoptosis/ tumor cell differentiation/ uterine cervical carcinoma
19	Sunscreen application /betacarotene supplementation in prevention of skin carcinomas
20	Serum cardiac troponin I as a marker for detection of acute myocardial infarction
21	Histology correlation/ atypical squamous cells/ low-grade squamous intraepithelial lesions
22	Endometrial biopsy in dysfunctional uterine bleeding
23	Membrane-associated protein complex with selective binding / clathrin coat adaptor AP1
24	Immunohistochemical analysis /type-X-collagen expression in osteoarthritis of the hip joint
25	Penetration of the olfactory mucosal epithelium by Naegleria
26	Effects of folate supplementation in hyperhomocysteinemic pigs
27	Metallothionein expression in carcinoma of the gallbladder
28	Proteoglycan changes in the extracellular matrix of lung tissue
29	Origin of hyperplastic epithelial cells in idiopathic collapsing glomerulopathy
30	Direct evidence that mitochondrial iron accumulation occurs in Friedreich ataxia
31	Allergen-induced eosinophil cytolysis in human upper airways
32	Glycosylphosphatidylinositol –anchored membrane proteins in psoriatic skin
33	Apoptosis associated with bcl-2 expression in premalignant and malignant breast lesions
34	Distribution of lymphocytes and adhesion molecule in human cervix and vagina
35	The interleukin-1 type I receptor is expressed in human hypothalamus
36	Homocysteine and heart disease: pathophysiology of extracellular matrix
37	Predictors of renal transplant histology at three months
38	Identifying women with cervical neoplasia
39	The characteristics of umbilical cord blood and umbilical cord blood transplantation
40	Does histology influence outcome in childhood Hodgkin's disease?
41	A caspase-activated DNase that degrades DNA during apoptosis
42	Radial scars in benign breast-biopsy specimens and the risk of breast cancer
43	Lamivudine therapy for hepatitis B infection
44	The histopathology of cutaneous lesions of Kikuchi's disease
45	A comparison of three fingerstick, whole blood antibody tests
46	Regeneration of dorsal column fibers following adult spinal cord injury
47	Pulmonary pathology in Gaucher's disease
48	Histological phenotypes of enteric smooth muscle disease
49	Histochemistry to detect Helix pomatia lectin binding in breast cancer
50	Benign neoplasms of the skin
51	Induction of tumor necrosis factor alpha production by human hepatocytes
52	Immunohistochemical differentiation of metastases of renal carcinomas
53	Performance and muscle fiber adaptations to creatine supplementation
54	Skeletal myoblast transplantation for repair of myocardial necrosis
55	Papilloma viruses, warts, carcinoma and Langerhans cells
56	Changes in nasal epithelium in patients with severe chronic sinusitis

The role of family medicine educators in teaching EBM to third-year students was described by Wadland and coworkers.[5] However, because clinical faculty had limited experience and training in critical appraisal and research methodology, they attended a 2-day training seminar given by McMaster University faculty before the EBM program was implemented. After clinical faculty training, nine 2- to 3-hour sessions were used to teach third-year students computerized literature searches, medical research paper structure, critical appraisal methods, and oral presentation skills. Survey results from this study showed higher levels of confidence in critical appraisal and research skills. Two cohorts followed into residency reported more appreciation of the instruction and skills obtained from the EBM program than did recent graduates. The authors indicate that the most important finding was that family medicine educators could successfully lead a standardized EBM program across multiple community campuses.

Ghali and colleagues[6] reported the effects of teaching a four-week EBM course to third-year medical students. Four 90-minute sessions were used to instruct students on clinical question development, MEDLINE searching, critical appraisal, and application of evidence. Third-year students receiving the EBM intervention reported increased self-assessed skills and attitudes, as well as a tendency to use MEDLINE and original research articles to solve clinical problems compared to a control group of third-year students. The authors concluded that the positive impact of their brief EBM intervention was due to active student involvement, clinical relevance and exposure to entire process of evidence-based problem solving.

Teaching critical appraisal to third-year students, using a journal club and letter writing approach during a three-week public health medicine attachment was described by Edwards and coworkers.[15] Small groups of students evaluated a recently published research paper, presented their appraisal to their peers in a journal club, and wrote a letter to the journal editor. Student feedback was "overwhelmingly positive" and 26 letters had been published or accepted for publication. The authors concluded that their approach was an innovative and enjoyable method for teaching critical appraisal and writing skills to medical students.

One study reported teaching EBM throughout the four-year undergraduate medical curriculum.[4] During the preclinical years, students were introduced to Medical informatics, literature appraisal skills and presentation skills in Library Sciences, Epidemiology and Microbiology, respectively. Students learned how to ask a clinical question based on an individual patient, search and appraise retrieved articles, and apply the information to the patient's medical problem during their clinical clerkships. The outcome measure developed to assess the program showed an improvement in students' search skill strategies, and ability to assess accurately the study's methodology and findings. However, students' ability to identify relevant studies in order to reach the appropriate conclusion about the question at hand was equivocal. The authors concluded that more data were required before drawing a definitive conclusion about the effectiveness of their integrated approach.

Because undergraduate medical students are expected to learn massive volumes of basic and clinical science information in a relatively brief period, they become proficient at memorizing detailed information found in instructors' lecture notes, textbooks, and their own hand-written lecture notes. This type of learning lends itself to readily accepting the written and spoken word of authority, rather than the critical appraisal of information. To address this problem, we developed and implemented a resource-efficient method for introducing our first-year medical students to the critical appraisal of biomedical research publications. Our perception of students' interest toward studying histology was a second reason for conducting the study.

When we implemented our supplemental critical appraisal program into the first-year histology course, the University of Health Sciences College of Osteopathic Medicine (UHS-COM) was utilizing a conventional curriculum in which basic sciences were taught separate from the clinical sciences. Our students seemed to view basic sciences in general and histology in particular as a hurdle to get over in order to enter the clinical component of their medical education. Several studies corroborate this supposition by reporting that medical students' focus is on acquiring skills to practice clinical medicine[16] and a lack of interest toward basic sciences that are taught in conventional curricula.[17-19] Our students' indifference toward histology motivated us to implement a fresh and practical way of demonstrating histology's relevance to the field of medicine.

Materials and Methods

At the beginning of the first-year histology course, medical students from the graduating class of 2003 (n = 224) at UHS-COM, were randomly divided into 56 groups of four students. A timetable outlining the entire critical appraisal program is listed in Table 1. During the first four weeks of the histology course, students were instructed on the basics of conducting a MEDLINE search and asked to review the biomedical literature for an article that contained histological and clinical elements. Groups were required to submit a copy of the abstract from their selected article for topic approval by the end of week eight. Students' publication topics are presented in Table 2.

Between weeks eight and 12 of the histology course, students were asked to attend two 60-minute seminars on how to critically appraise biomedical publications. The first seminar addressed the typical parts (i.e., abstract, introduction, materials and methods, results, discussion and conclusions) of a biomedical publication and how to critically analyze each component. The second seminar focused on questions to ask when reading diagnostic and treatment studies. A histology instructor gave both seminars during lunch. After the two critical appraisal seminars, groups were asked to meet at a mutually convenient time

and answer a set of critical appraisal-type questions (Figure 1). Groups were instructed to type a one-page summary of their approved article by week 12 of the course, using the guidelines provided in Figure 2. By week 15, groups submitted their one-page summary and the answers to the set of critical appraisal questions for instructor analysis.

During weeks 16-19 of the histology course, students revised their one-page summary based on instructor feedback and prepared a four-minute oral presentation for their classmates, faculty and administration. Group oral presentations were given during weeks 20 and 21 of the histology course. Each group member was required to present one of the following four components: introduction, methods, results, and discussion/analysis. After each group's oral presentation, first-year students, faculty and administration were encouraged to ask questions.

Group presentations were evaluated based on professional appearance and conduct, presentation organization, presentation clarity, analysis and critique, and the quality of the final abstract (Figure 3). These five attributes were worth four points each (i.e., 20 points total) towards the final histology course grade (460 total histology course points). Thus, the entire critical appraisal project was worth 4.3% of their final grade.

Figure 1. Critical Appraisal-Type Questions.

1. What do the terms used in the title mean?
2. What was the purpose of the study?
3. Why was the study needed?
4. What methods were used to address the research hypothesis?
5. What was the statistical hypothesis?
6. Why were the said statistical methods used for these data?
7. What did the results show?
8. Are the results consistent with the methods described?
9. Does the discussion highlight the important findings?
10. Was there needless speculation and discussion of unpublished data?
11. Did the conclusions answer the purpose of the study?
12. Do you agree with the conclusions made?
13. What would you have done differently?

Table 3. Student Survey Results of Critical Appraisal Program.

Survey Statements	**1 to 5 Rating*; Number of students (n = 51); (%)**					**Mean Rating (S.D.)**
	"1"	**"2"**	**"3"**	**"4"**	**"5"**	
Critical Appraisal program helped demonstrate relevance of histology to practice of medicine	2 (3.9%)	5 (9.8%)	6 (11.8%)	29 (56.9%)	9 (17.6%)	3.745 (0.997)
Other D.O. and/or M.D. medical students receive more critically appraisal training	3 (5.9%)	14 (27.4%)	12 (23.5%)	11 (21.6%)	11 (21.6%)	3.255 (1.246)
Critical Appraisal program positively affected my attitude toward histology	1 (2.0%)	8 (15.7%)	14 (27.4%)	20 (39.2%)	8 (15.7%)	3.510 (1.007)
Critical Appraisal program helped in other courses	1 (2.0%)	3 (5.9%)	9 (17.6%)	29 (56.9%)	9 (17.6%)	3.824 (0.865)
Time spent completing Critical Appraisal program was manageable	0 (0.0%)	0 (0.0%)	2 (3.9%)	38 (74.5%)	11 (21.6%)	4.176 (0.478)
Critical Appraisal program fostered collegiality among classmates	0 (0.0%)	2 (3.9%)	11 (21.6%)	25 (49.0%)	13 (25.5%)	3.961 (0.799)
Critical Appraisal program should be expanded throughout first and second years of medical school	2 (3.9%)	3 (5.9%)	12 (23.5%)	22 (43.2%)	12 (23.5%)	3.765 (1.012)
Critical Appraisal program was worth the effort	0 (0.0%)	3 (5.9%)	4 (7.8%)	32 (62.8%)	12 (23.5%)	4.039 (0.747)

Rating Scale: "1" indicates disagree strongly; "2" indicates disagree; "3" indicates no opinion; "4" indicates agree; and "5" indicates strongly agree

To determine whether the students considered our critical appraisal program useful and to address some related questions/issues, we constructed and administered a student survey to the class of 2003 during their senior year of medical school (Figure 4). Because our fourth-year students are completing their clinical clerkships throughout the United States, the survey was distributed via electronic mail. Survey responses were analyzed using Sigma Stat for Windows, version 2.03, SPSS, Inc.

RESULTS

Fifty-one students from the class of 2003 (N = 224) completed and returned our Critical Appraisal Program student survey (Figure 4). Students were asked to rate each of the eight statements using the following scale: "1" indicates disagree strongly; "2" indicates disagree; "3" indicates no opinion; "4" indicates agree; and "5" indicates strongly agree. Using frequency analysis, Table 3 summarizes student ratings and the corresponding percent of total respondents for each of the eight statements. Additionally, the mean rating and standard deviation for each statement are also listed in Table 3.

The most populous consensus among nearly all respondents (i.e., 96.1% agreed and strongly agreed) was that the time needed to complete Critical Appraisal program was manageable. Nearly three-quarters of the respondents (74.5%) agreed and strongly agreed that the Critical Appraisal program demonstrated the relevance of histology to medicine, helped in other courses, and fostered collegiality among classmates. Two-thirds of respondents agreed and strongly agreed that the Critical Appraisal program should be expanded throughout the first and second years of medical school. More than one-half of respondents agreed and strongly agreed that the Critical appraisal program had a positive effect on their attitude toward histology. Survey respondents' rating for whether osteopathic and allopathic counterparts received more critical appraisal training was similarly distributed from disagree to agree strongly. Finally, more than fourth-fifths of respondents (86.3%) agreed and strongly agreed that the Critical appraisal program was worth the effort.

DISCUSSION

Physicians indicate that medical journal reading is the most important activity for keeping updated, ranking above textbooks, colleagues, continued education courses, and pharmaceutical representatives.[20] Thus, critical analysis of published information is an essential component to the practice of medicine. The program described herein introduced critical reading of biomedical literature to first-year medical students, while illustrating the applicability of histology to the practice of medicine. Results from student survey data (Table 3) indicate that the course appraisal program was worthwhile and had a positive effect on their attitude toward histology. To motivate students to complete the critical appraisal program, students were graded on their group's one-page summary and platform presentation.

Figure 2. Instruction for One-page Summary.

The first part of the summary should contain the introduction. Definitions of the major terms used in the title, the clinical importance of the topic, and the purpose of the study are common items to put into the introduction. The second component of the summary is the material and methods section. This part usually consists of a few sentences describing the methodology used to investigate the clinical research question(s) (e.g., patient/subject number, clinical instruments used, etc.). Acquire a basic understanding of the clinical equipment/techniques used in the study before giving your oral presentation. The third part of the summary is the results. Quantitative and qualitative, clinically-measured outcomes are described in this section. Again, make sure that you have a basic understanding of results. For example, if data are presented as mean ± standard deviation (SD), you should know why the SD is given. The fourth part of the summary is the conclusions of the study. It is imperative that you PARAPHRASE and not PLAGIARIZE the publication's abstract. Remember, you are required to submit the original abstract. The fifth and most important component of the summary is the analysis section. This is where your group describes the strengths, limitations, and applicability of the study. Do not forget to spell and grammar check your work. Plan to use transparencies for your oral presentation. Remember that you only have four minutes to present your study. You may want to use the first three minutes highlighting the introduction, methods, results and conclusions; and the last minute critically analyzing the study.

Each group submitted a drafted version of their one-page summary to the histology instructors for review by week 15 of the course. The drafted summaries were evaluated on the basis of content, organization, distinctiveness from the publication's abstract, and grammar and spelling. Overall, the quality of the drafted one-page summaries ranged from very well written to poorly written. During weeks 16-19 of the course, each group had the option to revise their critiqued summary before its final submission (weeks 20-21). All groups chose to revise their drafted one-page summary before its final submission. The quality of the summary was worth only four points out of 460 total course points (<1% total course points). Although most students are "point-driven" in medical school, we believe students' pride and instructors' expectations may have played a role in their decision to revise their extensively reviewed one-page summary.

The quality of group oral presentations (Figure 4) was more impressive than their one-page summaries. Even though only about 3% (i.e., 16 points out of 460 total course points) of total histology course points were associated with each group's oral presentation, all groups appeared to have put a great amount of time and effort into this part of the critical appraisal program. All groups exhibited a high degree of professionalism, organization, clarity, and critical analysis during their verbal presentations. Students were advised to use either the document camera or the overhead projector for

the sake of simplicity, yet over 75% of groups created Microsoft PowerPoint® presentations that included scanned images and custom animations. Because no formal training was given on how to use Microsoft PowerPoint®, we believe that many students learned to use the program independently during the histology course. An unexpected and unsolicited comment made by many students was that the time and effort required to prepare their four-minute oral presentation gave them a greater understanding and respect for instructors' 50-minute lectures.

Although student, faculty and administration feedback for this program was enthusiastic, some areas of this program require further consideration for future use. Randomization of our first-year students (N = 224) into groups of four encouraged interactions among students that probably would not have otherwise occurred. Because our first-year students are permanently divided into the same four groups (i.e., A, B, C, and D) during the preclinical years for attending various basic science laboratories, some students expressed difficulty scheduling daytime group meetings when its members were not in the same laboratory group.

Students were encouraged to select a topic of interest, yet it was to contain histological and clinical components. Two issues related to topic selection that were not considered in the creation of this method were study/publication type and date of publication. The two critical appraisal seminars, and the critical appraisal questions and answers assignment were directed toward "experimental" type of biomedical publications. The type of study/publication selected by student groups was variable and included "review" articles, "retrospective" studies, "prospective" studies, "clinical trials," and biomedical "experimental" studies. Allowing students to select any type of publication exposed the first-year class to a variety of biomedical studies that was not addressed during the two critical appraisal seminars. A limitation to our approach was that some students were had difficulty in completing the project within its original format (e.g., data analysis).

Most students selected articles that were published within the last decade. However, several groups selected papers that were decades old. Because physicians should be able to critically evaluate the outcomes of contemporary medical research studies to provide the best possible patient care, we believe one of the greatest limitations of our critical appraisal program was not limiting the publication's date.

Although we provided our students with only two one-hour seminars on how to critically analyze biomedical publications, there is published data to support its usefulness. Landry and coworkers[12] found that after two 90-minute seminars, third-year medical students were more likely to consider study design important in article selection and the use of medical literature critical to patient care decisions. The format of our two one-hour seminars was kept informal and occurred during lunch. Seminar information was presented in PowerPoint® format and placed on our intranet for students unable to attend.

Figure 3. Example of a Group's Final Abstract.

Transplantability and therapeutic effects of bone marrow-derived mesenchymal cells in children with osteogenesis imperfecta

Osteogenesis Imperfecta (OI) is a genetic disorder involving abnormalities in mesenchymal cells which lead to a generalized osteopenia causing bone deformity, fractures, and fragility. A mutation in one of the two genes (**COL1A1**, **COL1A2**) coding for the primary structural protein of bone (collagen) is responsible for this progressive disorder which currently has no cure. Previous studies aimed at correcting this disorder came from murine models (rat studies). This is the first study in which human bone marrow was infused into human specimens. Three children suffering from 01 due to genetic defects in collagen were used as subjects. The bone marrow was harvested from a sibling donor and intravenously infused into each patient. Chemoprophalyxis consisting of intravenous cyclosporine was given to each marrow recipient (2.5mg/kg every 12 hours) in order to reduce the chance of graft-versus-host disease. Each subject was evaluated prior to and following bone marrow transplantation. Results of the study were based on growth evaluation, bone histology studies, mesenchymal cell culture, chimerism studies, and dual energy x-ray absorptiometry. Bone biopsies taken from the iliac wing of each patient before and after the treatment demonstrated lamellar bone formation, greater osteoblast organization, and an increase in the number of osteoblasts per high-power field after transplantation {4.6 $\pm$ 1.8 (s.e.m.) before and 16.0 $\pm$ 3.0 after transplantation (P = 0.005, t-test)}. Other positive results were observed by the increase in total body bone mineral content in two of the three patients. One convincing factor which strongly supported the transplantation was the decreased number of fractures in all three patients. Therefore, this study demonstrates that mesenchymal progenitor cells in transplanted bone marrow of normal individuals give rise to osteoblasts. The presence of these new osteoblasts is seen in improved bone structure and function in individuals suffering from OI whose osteoblasts are genetically defective. Research indicates that the severity of OI depends on the ratio of normal to mutated pro-alpha polypeptide chains, therefore a relatively small percentage of mesenchymal cells (only 1.5 - 2.0% used in this study) may be enough to push the balance toward the normal side. It is possible that the increase in normal osteoblasts after the engraftment was short lived. It's also possible (though unlikely) that the therapeutic events seen after engraftment were caused by engraftment procedures (total-body irradiation & cytotoxic drugs). We feel that this study, being the first one to be conducted on humans, was very valuable and was conducted in a very scientific manner. It appears that protocols were followed in order to eliminate any errors due to bias and the results obtained seemed to be statistically and clinically significant. One aspect of the study that we felt was somewhat lacking was the number of subjects in the study. Another concern was that descriptive data about the control group wasn't listed. Overall we feel that this experiment justifies further tests to be performed in order to determine if infusing donor bone marrow into OI patients results in a cure for the disease.

Figure 4. Student Survey of Critical Appraisal Program

A. The Critical Appraisal program helped demonstrate the relevance of histology to the practice of medicine.
B. Other D.O. and/or M.D. medical students receive more training on how to critically read and evaluate biomedical literature than we did at UHS.
C. The Critical Appraisal program had a positive effect on my attitude toward the histology course.
D. The Critical Appraisal program was helpful in other courses.
E. The time spent completing the Critical Appraisal program was manageable.
F. The Critical Appraisal program fostered collegiality among classmates.
G. The content of the Critical Appraisal program should be expanded and delivered throughout the first and second years of medical school.
H. The Critical Appraisal program was worth the effort.

CONCLUSION

Clinicians must be trained to not accept published medical research studies at face value, but to form their own conclusions after careful and critical review. The program described herein is a resource-efficient way to introduce critical reading of biomedical literature to first-year medical students, while illustrating the applicability of microscopic anatomy to the practice of medicine. Our critical appraisal program also gave students a "taste" of scientific writing and an opportunity to learn platform presentation skills.

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Figure 5. Example of Two Groups' Oral Presentation.

A Digital Approach to Cellular Ultrastructure in Medical Histology: Creation and Implementation of an Interactive Atlas of Electron Microscopy

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ABSTRACT

This study investigated student acceptance of a digital atlas of electron microscopy (EM) in the 2001 medical histology course at the University of Kentucky. The course's set of electron micrographs was digitized and incorporated into an instructional multimedia program using Macromedia™ Authorware 5.2. Student attitudinal survey data was collected prior to digital EM atlas use and again at the end of the semester. Most students (88%) reported using the digital EM atlas for study at home rather than on campus, while only 31% reported using similar learning tools at home prior to medical school. A significantly higher proportion of students used the EM atlas for independent study than they did with prior computer-assisted instruction (CAI). In addition, the reported frequency of CAI use decreased between pre- and post-use surveys. Prior to medical school, 29% of students reported using CAI routinely, while only 6% of students used the digital EM atlas on a routine, weekly basis. Instead, most students (83%) used the digital EM atlas primarily as a review during the week prior to examination. Nevertheless, students were significantly more enthusiastic (more respondents strongly agreed) that their study efficiency and exam performance was increased after using the EM atlas as compared with other CAI they had used. Students' prior histology experience or lack thereof, had no significant effect on their attitudes toward or use of the digital EM atlas.

INTRODUCTION

At the University of Kentucky, the medical histology course is an interdisciplinary, team-taught course that integrates the basic science of cell biology and histology with its clinical relevance (neuroscience, hematology, endocrinology, urology). Medical histology is taught in the first block of coursework, from August through October. Four faculty members provide lecture instruction and laboratory assistance to 95 first year medical students during each laboratory period.

Traditionally, histology students at the University of Kentucky studied cellular ultrastructure in the laboratory using a labeled set of electron micrographs, organized into three notebooks by topic. An accompanying set of unlabeled micrographs was available for self-testing purposes. Student use of the images in these notebooks was restricted to the histology laboratory; they had no comprehensive atlas or reference guide to facilitate their study at home or in the medical library, thereby limiting their flexibility in studying cellular ultrastructure.

This instructional dilemma presented an ideal opportunity for incorporating computer-assisted instruction (CAI) into the course by converting the micrographs in the notebooks into an accessible, interactive multimedia program. The use of CAI has become commonplace in both the basic science [1-3] and clinical aspects of medical education.[4-7] As curricular demands increase and contact hours are reduced, CAI plays an increasingly important role in the delivery of instructional materials earmarked for independent study. CAI has proven to be particularly useful in facilitating independent study in anatomical instruction, since it provides an effective and efficient way to learn visual material.[8-10] In fact, at the University of Kentucky, instructional multimedia serves as an integral component of medical gross anatomy to facilitate independent study of cross sectional anatomy, radiology and osteology. During their third block of coursework, our students use a customized digital neuroscience atlas to guide their study of neuroanatomy.[11]

A number of medical schools have demonstrated that CAI is a viable addition to, if not a replacement for, glass slides and microscopes in medical histology.[8, 9, 12-15] Although the study of cellular ultrastructure by electron microscopy (EM) is an integral part of many medical histology courses, this topic is sparsely covered in most commercial histology atlases, which instead emphasize light micrographs. This study reports on the development and implementation of a

digital atlas of electron microscopy and the resultant student perceptions and attitudes towards the value of CAI as a tool for independent study of cellular ultrastructure.

MATERIALS AND METHODS

The Atlas

In order to facilitate student independent study of cellular ultrastructure, a customized digital atlas was constructed during the summer of 2001 using the multimedia-authoring program Macromedia™ *Authorware 5*. Unlabeled electron micrographs from the course set of notebooks were digitized using a flat bed scanner at a resolution of 1200 dpi. The images were digitally enhanced using Adobe Photoshop and imported into Macromedia™ *Authorware 5*. This program provides an icon-based template for creating sophisticated instructional multimedia with a minimal amount of programming skills.

The atlas consists of 12 self-study units, including cytology, epithelia, connective tissue, muscle, nerve, blood and circulatory system, as well as digestive, endocrine, respiratory, reproductive and urinary systems. Each screen displays an electron micrograph and an interactive list of key terms for identification. As students move their cursor over each term listed, the term and the corresponding structure on the image are highlighted (Figure 1A). Additionally, as a student passes the cursor over structures on the EM, the appropriate term is highlighted (Figure 1B). A "search" feature enables students to locate a specific structure quickly, without navigating aimlessly through each module. An in-class demonstration of the atlas' functionality was given during the first week of class and the program was distributed to all students on CD.

Student surveys and statistical analysis

The impact of incorporating the atlas into the medical histology course was assessed using pre- and post-use surveys (Table 1). Both surveys included ten questions regarding students' demographic information (including parameters such as age, gender, undergraduate major), as well as queries regarding students' attitudes toward CAI, recorded on a five-point Likert-type scale (strongly agree, agree, no opinion, disagree, strongly disagree). In addition, each survey provided space for students' subjective comments.

The pre-use survey was administered during the first week of medical histology in order to understand students' experiences with instructional technology during their undergraduate experience. During the last week of the course, the post-use survey measured student usage patterns and satisfaction level with specific aspects of the digital EM atlas. Data collected from the post-use survey included frequency and location of use of the EM atlas, as well as its impact on learning efficiency, exam performance and "out of class" study time, as perceived by the students.

Figure 1. User interface of the digital EM atlas. Student users can pass their cursor over the list of key terms to highlight structures on each electron micrograph (Figure 1A Top). Alternatively, students may opt to pass their cursor over structures in each electron micrograph; when a key structure is passed over with the cursor, its term is highlighted in the identification list (Figure 1B Bottom).

Statistical analyses were performed using chi-square tests to detect significant differences in frequency data. The proportion of students responding in each of the five categories (strongly agree to strongly disagree) was calculated from the pre-use survey and this proportion was multiplied by the total number of respondents for each question in post use survey to calculate expected values. An exemption certification for this study (Protocol 01-0689-X3Q) was granted from the University of Kentucky's Institutional Review Board.

RESULTS

Atlas Usage Patterns

The overall response rate for pre- and post-use questionnaires (2001) was 98% (n = 93 respondents out of a

Table 1. Sample survey questions.

Pre-use survey				
Rate your level of comfort in using CAI	Very comfortable	Comfortable	Uncomfortable	Very uncomfortable
How often did you use CAI in pre-medical courses?	Weekly	Weekly	Never/rarely used the programs	
What mode of information delivery do you prefer	Internet	CD	No preference	
Post-use survey				
Where did you use the atlas most often?	At home	In the library	In the lab	Other
Which statement best describes your use of the atlas.	Group study	Independent study	Used in both ways	
The atlas increased your efficiency in learning EM's.	Strongly agree	Agree	No Opinion	Disagree	Strongly Disagree
The atlas enhanced your performance on the EM component of practical exams.				
The atlas reduced "out of class" study time spent in the laboratory.				

total of 95 students). Fifty -six (60%) of the respondents were male students and 37 (40%) were female.

When queried about their comfort level with CAI (based on their undergraduate or pre-medical experience) in the pre-use survey, 37% of the class reported feeling very comfortable using CAI, while 54% were comfortable and 9% expressed a significant level of discomfort using computer-based instructional technology. Regarding location of atlas use, most students (88%) reported using it primarily for study at home rather than in the laboratory, library or student computer lab. By contrast, the pre-use survey revealed that only 31% of these students reported using computer-assisted learning tools at home prior to medical school.

Both pre- and post-use survey data indicated students' preference for using CAI for independent study as compared to group study (Figure 2). A significant increase in students using CAI for independent study was observed between pre- and post-use survey data (Table 2). Additionally, fewer students reported using the atlas in groups as compared to their use of prior CAI (Figure 2).

When comparing CAI usage patterns in students' undergraduate experiences with atlas usage patterns in medical school, a number of differences were observed. The overall frequency of CAI use was elevated in medical school, as compared to CAI use in the undergraduate experience (Figure 3). Prior to medical school, 29% of

Table 2. Summary of significant differences between pre- and post-use survey data.

	Pre-use survey	**Post-use survey**	**Chi-Square**	**p value**
Used CAI for independent study	67%	87%	19.8	$p<0.001$
Strongly agreed that CAI increased study efficiency	13%	51%	121.7	$p<0.001$
Strongly agreed that CAI enhanced lab performance	16%	35%	42.55	$p<0.001$

Percentages represent the proportion of student respondents who chose the survey options indicated. Significant differences between pre- and post-use surveys were identified by Chi-square analysis.

Figure 2. Atlas usage patterns. Three types of student study behaviors were observed across the pre- and post-use surveys: independent study only, group study only and combined independent and group study. A significant increase in atlas use for independent study was observed in the post-use survey data. No students reported using the atlas for group use exclusively in the post-use survey.

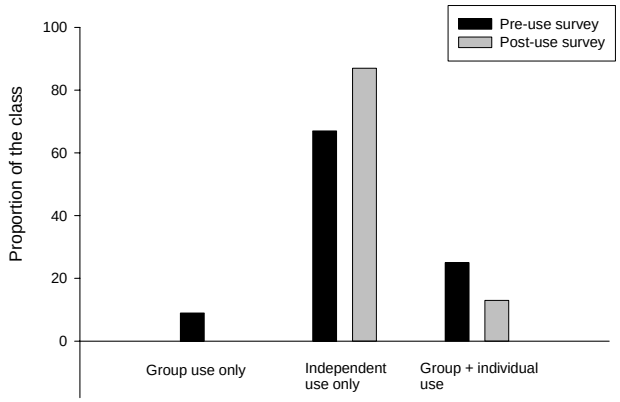
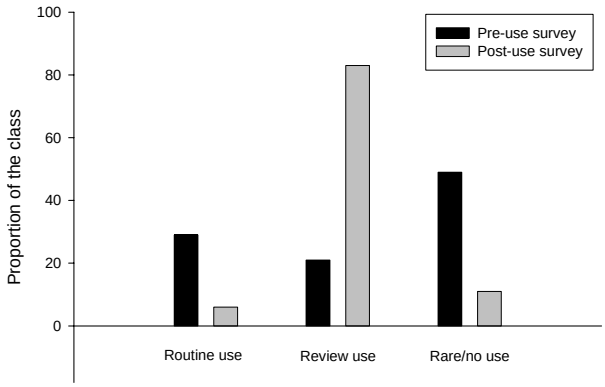


Figure 3. Frequency of atlas use. When use of the EM atlas was compared with prior undergraduate use of computer assisted instruction, the post-use survey revealed that weekly use declined and review use increased.



students reported using CAI routinely, while only 6% of students used the digital atlas on a routine, weekly basis. Instead, most students (83%) used the digital atlas primarily as a review prior to examinations.

Students were significantly more enthusiastic (more students strongly agreed) that their study efficiency was increased after using the atlas as compared with CAI they used in their other first- year medical courses (Figure 4; Table 2). More students strongly agreed that performance was increased after using the atlas than with other CAI they had used (Figure 5; Table 2). While most students expressed that use of the atlas reduced their study time in the laboratory (38% strongly agreed; 47% agreed; 10% disagreed; 5% strongly disagreed), they were less enthusiastic about the atlas' effect on this aspect of their study behavior.

Forty-two percent of the class reported taking histology as undergraduate students in the pre- and post-use surveys. Students' prior histology experience or lack thereof had no significant effect on their attitudes toward or use of the atlas; there were no significant differences in attitudes towards CAI or atlas usage patterns between these two subgroups of the class.

DISCUSSION

The present study evaluated student acceptance of a computer-based atlas of electron microscopy introduced into the medical histology course at the University of Kentucky in 2001. Traditionally, students mastered cellular ultrastructure by independent study of labeled electron micrographs (EMs) in a series of large notebooks restricted to use in the laboratory. Since these EMs were not available for checkout from the lab and most medical histology atlases lack a substantial ultrastructural component, students had no resources available to them for off-site study.

As expected, the introduction of the digital EM atlas evoked an overwhelmingly positive student response. The majority of the class reported that the atlas not only made their study more efficient and convenient, but felt it enhanced their performance on lab practical exams as well. Students' subjective comments indicated that using the atlas took "the guesswork" out of mastering the sub-cellular anatomy of the electron micrographs, as many of the micrographs in the lab notebooks were unlabeled. Student satisfaction levels with the EM atlas were significantly higher than those reported for CAI used in the undergraduate experience, probably because the EM atlas was constructed "in-house," with specific course objectives in mind. The atlas was designed to provide a portable and convenient means by which to study cellular ultrastructure. For a quick review of important structures, students simply put their cursor over individual terms in the identification list to highlight each structure on the micrograph. For a more thorough review, students had the option of "exploring" each micrograph with their mouse; as they passed over a structure on the EM, the appropriate term in the identification list became highlighted.

Despite the students' strong support for the program, as measured by the post-use survey, they primarily used the atlas for review one to two days prior to examinations, rather than as a routine component of their study regime. This pattern of EM study parallels that observed prior to introduction of the digital atlas. The daily laboratory exercises emphasized identification using light microscopy,

Figure 4. Impact of atlas on study efficiency. Students were significantly more enthusiastic about the effect of the EM atlas on their study efficiency than they were about prior CAI.

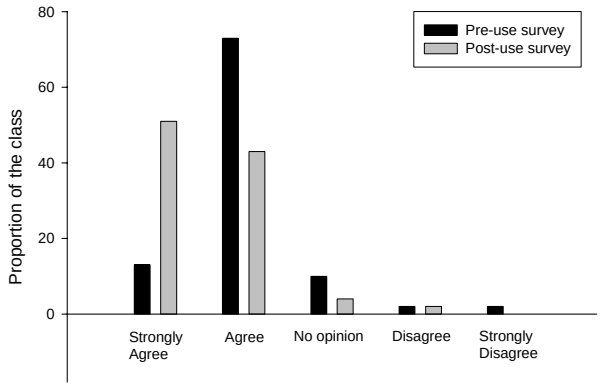
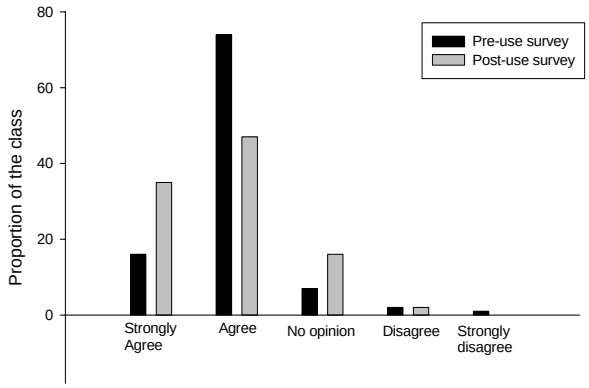


Figure 5. Impact of the digital atlas on laboratory examination performance. More students strongly agreed that the EM atlas enhanced their lab practical performance, as compared to prior CAI.



with EM structures listed at the end of each lab session, at a time when many students were rushing to complete their microscope work for the day. As a result, many students left the EM work for "last minute" study just prior to the lab practical exam. McNulty and colleagues [16] have reported that even digital histology programs focusing on light microscopic images may be accessed "occasionally," rather than weekly or daily, by more than one- third of the class. Increased use of CAI prior to examinations is a common student behavior at all academic levels, however, and has been documented in electronic tracking studies of medical students using web-based CAI.[16]

Efforts are currently underway to encourage students to incorporate the digital EM atlas into their routine study schedule. Modifications in the design of the atlas and lab manual may promote more consistent student use of the atlas. Construction of an interactive quiz module has been initiated in order to promote periodic self- evaluation. In the current form of the course's lab manual, a list of key EM structures is included at the end of each lab exercise in the course lab guide, so it is easy for students to overlook the EM work as they rush to finish their microscope work in the lab. By better integrating the EM work into each lab exercise in the lab manual, the students will view this aspect of the lab as an important facet of the lab experience, rather than an afterthought.

Students' subjective comments about the program indicate that cross- referencing the EM work in the lab manual and the EM atlas would facilitate their study of the material. Including EM structures on quizzes in addition to midterm and final exams may also encourage more consistent use of the program throughout the block. Incorporation of EM images into the daily lab previews might also serve as an added incentive.

CONCLUSIONS

This study describes a novel, customizable approach to teaching and learning cellular ultrastructure in medical histology. Students' attitudes about and use of the digital EM atlas differed significantly from computer-assisted instructional (CAI) programs they used in their pre-medical coursework. Students perceived the atlas to be more effective in increasing study efficiency and exam performance. A significantly higher proportion of students used the atlas solely for independent study than they did for pre-medical CAI. Atlas modifications are currently underway to encourage students to use the program for routine study, rather than solely for review purposes prior to exams.

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