

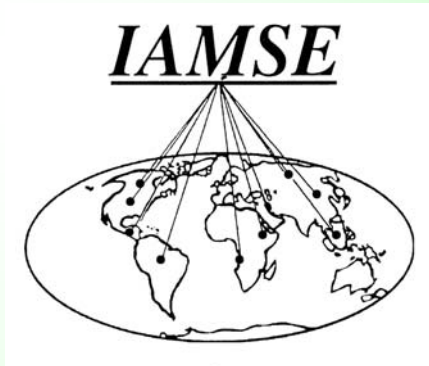
# JIAMSE

Journal of the International Association of Medical Science Educators

Volume 19

Number 2

2009



***Mock Malpractice Trial Format for Teaching***

***The Case of the "Disruptive Learner"***

***Effective Teaching of Biostatistics and  
Epidemiology***

***Change in Laptop Computer Use over Time***

***Attitudes toward Technology Enhanced  
Integrated Medical Curriculum***

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# JIAMSE

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# Message from Editor-in-Chief

**Uldis N. Streips, Ph.D.**  
Editor-in-Chief

Hello all JIAMSE readers!

We are now in the second issue of volume 19 of the Journal. As we have started this year, all publications are represented in this issue. I hope the information will be useful for you at your school and in the job you do. I always pick up something I can do better in the course I direct from reading the material submitted to JIAMSE.

I urge you all to think about educational research. Many medical schools are utilizing educators extensively, whose tenure and promotion depends on a portfolio of publication and presentation. Our journal review system is very user-friendly and lots of help is available for the authors from our tireless editorial board. Our production editor, Marshall Anderson, is also superb and your work will be published in the best format possible. All our published material, including Letters to the Editor is peer-reviewed thoroughly.

So, I wish you all good reading, good application of the ideas you read about, and I look forward to the manuscripts you will be sending my way.

Uldis N. Streips, Ph.D.  
Editor-in-Chief

# LETTER TO THE EDITOR

## Response to “Between God and Man: A Student’s Dilemma”

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There are multiple interesting ways where religion and medicine intersect. These range from the role of faith traditions in medical decision-making, theological medical ethics, randomized clinical trials of intercessory prayer, and the religious needs of healthcare providers and students. The case before us concerns accommodation and advocating for a Muslim medical student who seeks to observe his faith traditions including religious holidays, fasts, and daily prayer.

In my opinion, it is important for medical students to learn to address problems such as the one described in “Between God and Man” in a thoughtful and respectful fashion. To this end, we have created a new mandatory course for second-year medical students at the University of Louisville entitled “At the Intersection of Religion and Medicine.” Through case presentations, panel discussions, and correlative readings, we address issues such as the one raised in this case.

There are, of course, many examples of the “student’s dilemma” beyond that of the Muslim student. These include observant Jewish students who wish to wear a skull cap, the wearing of head coverings by Muslim female medical students, practical difficulties related to the desire of Muslim or Jewish students to have Halal or Kosher food, the need of students of various faith traditions to observe their religious holidays (the differing dates for Christmas, for example, between the Roman Catholic and Protestant traditions and the Eastern Orthodox traditions).

One must, of course, be respectful of the diverse faith traditions of medical students. Ultimately, however, our young Muslim student will come to appreciate the primacy of the patient’s needs and will have to adapt his faith observation to patient care.

In the same way that some religious-based hospitals have sought in the past to attract house officers by accommodating their religious needs, I think it is very likely as the United States becomes an increasingly diverse society that we will see internship and residency programs designed to meet the needs of the observant Muslim student.

# The Medical Educator's Resource Guide

John R. Cotter, Ph.D.

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*This issue of the Medical Educator's Resource Guide introduces us to websites concerned with embryology, the inner ear, radiology and eponyms.*

*Besides providing mini lessons on several aspects of embryological development, the developer of **Human Embryology Animations**, Dr. Valerie O'Loughlin, uses pre- and posts-tests to measure learning and a survey to evaluate the effectiveness of the instructional content and the animations used in the lessons. Participation in the practice tests, the post-tests and the survey is entirely anonymous and not required by the author.*

*It should be noted that the use of **Lieberman's eRadiology** is strictly limited by the terms and conditions set forth by the author. The restrictions serve as a reminder that a website cannot always be used freely even when the user only wishes to use the site or some aspect of the site for educational purposes.*

*The intent of **Who Named It?** is to provide background information on the men and women in science and medicine for which diseases, anatomical structures, tests and so on are named. Thus far, the website reports having over eight thousand eponyms, and with time, the number of entries is expected to nearly double.*

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## **Human Embryology Animations. Indiana University.**

[http://www.indiana.edu/~anat550/embryo\\_main/index.html](http://www.indiana.edu/~anat550/embryo_main/index.html)

The Indiana University website on human embryology contains computer animations that reconstruct the sequence of events involved in the embryological development of the heart, the gastrointestinal tract, and the head and neck regions of the body. The authors also plan to extend the site to include animations of limb and urogenital system development. The website's visual depiction of embryology is accompanied by a concise narrative. One drawback to the site is that it does not address all of the areas of embryology or congenital anomalies of the topics included in the site. The development of specific areas, e.g., the development of the parts of the heart, is illustrated with individual animations. The website features quizzes that test knowledge before and after viewing the animations. The brevity of the animations and an element of user control, i.e., the ability to pause and rewind the animations, encourage multiple viewings and therefore enhance comprehension of the material. The imagery combined with a variety of viewing angles provides a 3-dimensional view of development. (Reviewed by Basem Attum, M.S., University of Louisville Medical School.)

## **Introduction to Cochlear Mechanics.**

<http://umech.mit.edu/hearing/intro/intro.html>

Dr. Dennis Freeman has produced an outstanding and accessible visualization and explanation of the sensory cells in the inner ear and their response to sound. The website presents microscopic video images and animations of cochlear and cochlear hair cell movement as well as lucid text, electron microscope images, and diagrams. Stroboscopic microphotographs of the inner ear while stimulating the ear with sound are combined in sequence to produce brief video clips. The site includes images and diagrams of the hair cell and its stereocilia, with a description of their dimensions, physiological function, and the experimental method used including the use of optical sectioning. Most outstanding are the animations of cochlear micromechanics and videos of hair cell movement. The author describes the videos as the first such images of hair cell and tectorial membrane responses. Illustrations range from the macroscopic to the membrane level. The author is a professor of electrical engineering, but the site is useful for basic science instructors and students in physiology, neuroanatomy, and neurobiology. The images and videos can be assigned for self-study or inserted in PowerPoint presentations of the structure and physiology of the ear and its component parts. (Reviewed by Robert Lavine, Ph.D., The George Washington University School of Medicine and Health Sciences.)

## **Lieberman's eRadiology. Harvard Medical School.**

<http://eradiology.bidmc.harvard.edu/>

This website offers a comprehensive guide to learning radiology applicable to the clinical setting. Though the content is distinctly geared toward use by medical students and residents, anyone with a basic understanding of anatomy/radiology would find this site useful. In the

Primary Care Radiology section, case-based problems are presented in an easy Q and A format allowing the user to make interactive patient workup recommendations. The Tutorials sections offers in depth video presentations on radiological imaging of various areas of the body. The 'lesion localizer' link in this section does a beautiful job of interfacing clinical neurology with radiology. In the Classics section, users will find an array of archived images demonstrating typical pathology in nearly every part of the body. The links to Learning Labs and Living Anatomy offer an assortment of beneficial student-created presentations on clinical radiology. The website excels in its ability to help users make medical imaging diagnoses and concomitantly understand the clinical reasoning for such decisions. In most features, patient workup algorithm charts are available with emphasis on medical imaging choices. By simulating challenges found in the clinical setting and presenting them to the user, the site does a marvelous job of honing the skills of healthcare professional students exposed to radiological imaging. Overall, the website is simple to navigate and users will reap the rewards of its content in their ability to evaluate medical images. *(Reviewed by Paul Gruber, B.S., The Ohio State University.)*

### **Who Named It?**

[www.whonamedit.com](http://www.whonamedit.com)

Whonamedit.com is billed as the world's most comprehensive source of medical eponyms. When last viewed, it contained 8253 eponyms linked to 3270 persons. Users can search by using the name of a person, eponym or by searching a list of eponyms, categories, the names of people grouped by country of origin or the names of women. The repository of eponyms provides a definition, the names of the people associated with the eponym, and a biography of varying length. *(Reviewed by John R. Cotter, Ph.D., University at Buffalo.)*

*The Journal of the International Association of Medical Science Educators invites members to submit reviews of their favorite websites to The Medical Educator's Resource Guide. If you know of a website that is especially suited for education, send the submission to [jrcotter@buffalo.edu](mailto:jrcotter@buffalo.edu). Please include the URL and a short critique summarizing the content and utility of the site. All submissions will be reviewed for relevance, content and length. Revisions, if necessary, will be made in consultation with the author.*

# INNOVATION

## A Process for the Development of Core Objective Guidelines for Teaching Medical Microbiology and Immunology

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The Association of Medical Schools Microbiology and Immunology Chairs (AMSMIC) sponsor the Microbiology & Immunology Educational Strategies Workshop on a biennial schedule. At the 7<sup>th</sup> meeting held in 1998, a session was devoted to core learning objectives for teaching medical microbiology (separate objectives for fundamental/basic microbiology and pathogenesis/infectious diseases) and immunology/host defenses. These were interactive sessions lead by medical microbiology and immunology course directors. As a starting point, learning objectives discussed were an amalgam of objectives that were currently in use at several medical schools. Attendees at each of the three sessions could suggest additional objectives. No objectives were deleted. To prioritize the objectives, a show of hands was used to rank the objectives with respect to trivial (no need to include in curriculum), important (include if there is time), or essential knowledge. Although not widely disseminated, these served as guidelines for course directors until the 2006 biennial meeting. At that meeting, there were formal sessions to revisit core objective development, using the same format as utilized at the 1998 meeting. During the panel discussion following the breakout sessions, it was quickly realized that the "show of hands" method for prioritizing was slow and inaccurate. It was therefore proposed to develop a collaborative web site based upon the wiki<sup>1</sup> format. The web site was developed by the Division of Information Technology at Creighton University. At the 12<sup>th</sup> biennial meeting held in May, 2008, additional formal sessions were held to finalize the procedures for ranking the core objectives. Attendees of the 11<sup>th</sup> & 12<sup>th</sup> workshops have been provided passwords to allow them to edit and/or rank the posted objectives. At this writing, on-line ranking and editing of the objectives is in progress. The consensus of the attendees was that these core objectives should be used as a resource for course content and not an attempt to develop a national curriculum. Our intent is to



review and update the learning objectives every two years. The learning objectives are available for viewing at <http://mmi.creighton.edu/CoreObjectives/>

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# INNOVATION

## Mock Malpractice Trial Format Tests Students' Clinical Case Presentation Skills

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### ABSTRACT

Marshall University, JCESOM's second-year medical students worked in teams to debate the validity and interpretation of clinical-pathologic findings in a "mock-medical malpractice trial" setting. This teaching format is based on the principles of teamwork and critical thinking. Student feedback on this approach to clinical case-based teaching was overwhelmingly positive.

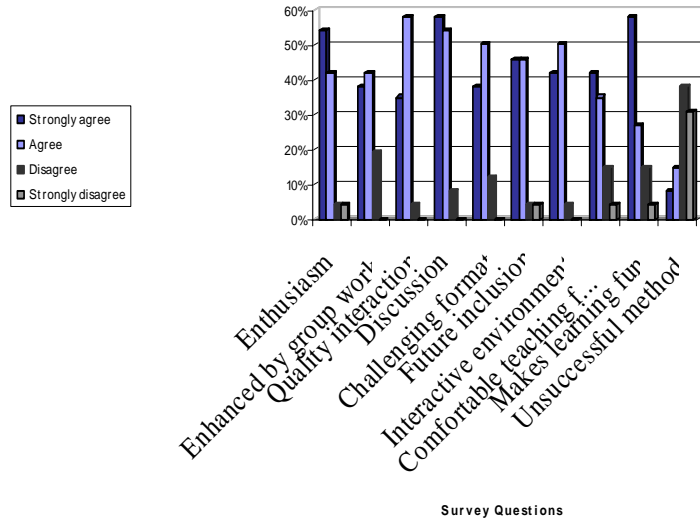
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A clinical pathology conference on tuberculosis was taken from the New England Journal of Medicine and used as the basis for our mock trial. The family of a 43 year-old man with fever and night sweats is suing the clinician, Dr. No, for delay in diagnosis. The trial was strictly student-driven, and the instructors were present only as facilitators. The class of 46 was divided into five groups: Judge (8), Prosecution (9), Defense (9), Witnesses for Prosecution (10), and Witnesses for Defense (10). Students were encouraged to work together as a group and select an individual(s) to act as the main presenter(s) for the group and interact with other groups. Students were given the freedom to choose a different interpretation of the data provided. For example, it was fair for the defense to have another pathologist testify with a different interpretation of the pathologic data. Upon request an image files of the pictures and figures in the article were provided. Students were surveyed for the effectiveness of this form of instruction.

The results of the survey indicate the following: 93% of the students indicated that quality interaction was created with this teaching format; 92% indicated that it stimulated interactive environment for learning; 96% agreed that it made learning fun. We believe this teaching format is useful for virtually any subject matter and variety of teaching modalities can add spice to good teaching.

Basic science years are often difficult for the students since the material can be overwhelming and dry. By creating active learning methods, students become motivated to master even the most tedious material. Although this teaching format is untraditional, it presents students with unusual challenges to better enable them to comprehend the material.

## Mock Trial Survey Results



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# MEDICAL EDUCATION CASE STUDY

## The Case of the “Disruptive Learner”: A Small Group Facilitator’s Nightmare

### Case Writer

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#### ABSTRACT

Small group learning involves pre-clinical students solving problems that potentially integrate basic medical science and clinically related correlates. However, a disruptive learner detracts and undermines the effective learning group process, necessitating the content or non-content expert facilitator to guide, challenge, offer feedback, and intervene when the process falters.

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Innotech University has undergone a recent curriculum change that incorporates small group teaching for pre-clinical medical students, adopting a problem-based learning format. Dr. Azuma has been assigned by his Bacteriology department chair to represent the department's required contribution to the teaching effort. Dr. Azuma is willing but failed to attend the medical education office's four hour Facilitator Training program. Instead he completes the less intense and inferior on-line version of skills and strategies necessary to involve pre-clinical students in the integrated basic and clinical sciences. English is his second language. His preference is to remain in his research lab, a truer reflection of role as a scientist.

He begins the eight week neurology block small group assignment with trepidation. On the first day he begins the session without setting any 'ground rules' for his nine students. He shares his less than enthusiastic regard for the small group, case-based instructional format. His initial conversation on the subject is directed at a student he recognizes from his recent summer research lab. After his prescriptive diatribe they commence reviewing the clinical neurology case when a student answers his cell phone, has a 'side-bar' discussion, then becomes highly opinionated on case content to the exclusion of his peers. Tensions begin to rise within the group. The other students anxiously wait for the facilitator to intervene in this rude and disruptive behavior. Yet no action is taken as they complete the case with only a few students offering any independent contributions to the case's etiologic or patho-physiologic implications.

The students assemble for the second class session finding continued dysfunction within the group. Two students address the issue of the disruptive student with the facilitator after class. Dr. Azuma indicates that he will read the Facilitator Guidelines and try to improve. Yet, no substantial changes occur. A disruptive learner frequently detracts and undermines the cohesion of the learning group, if not appropriately corrected. In desperation the students take their complaint in person to the Course Director.

The Course Director calls Dr. Azuma. "I appreciate your efforts facilitating students in our 'neuro' course", the Director explains. "If you still wish to continue, I can offer some resources to help you be more effective. Would that be OK with you?" Small group facilitators have numerous responsibilities. Likewise, the Course Director responsibilities may include effective management of course content, faculty supervision and assessment. In our case study

the Director may offer to consult with the facilitator offering several immediate and long-term strategies to encourage improvement. Perhaps co-facilitating the next small group session to role-model essential skills may rectify disruptive student behaviors. Jointly reviewing the Facilitator Training guidelines may reinforce useful skills. In addition, a short review session with a medical education specialist could assist in managing disruptive behaviors. Finally, obtaining a replacement facilitator could be a difficult or troublesome option.

It is assumed that small group learning challenges and expands students' understanding of clinical cases with information often derived from lectures, laboratories and reading assignments. Small group leaders may consider several strategies for disruptive learners, as illustrated in our case. Making direct eye contact with the disruptive student may gain their attention. They may redirect the groups' discussion when the group process breaks down (i.e., "Let's get back on track" or "Thank you, now let's hear from others") are subtle means of altering disruptive behaviors. If needed, take a "time out" or a brief recess for direct, personal feedback with the student. Reflection on important 'ground rules' or expectations could mollify inappropriate outcomes. If unable to resolve the learner's issues then contacting the Course Director for an immediate remedy is appropriate.

### **Summary:**

Disruptive student behaviors are a facilitator's worst nightmare, often altering the effective group process. Such group disruptions may include: 'side conversations'; dominating behaviors; non-participant or silent student behaviors. The facilitator has a considerable responsibility when guiding a small group of pre-clinical students in case-based discussion sessions. They are often expected to stimulate student responsibility for achieving self-directed and life-long learning while sustaining the collaborative group process. Effective group problem-solving requires a skilled facilitator who guides, challenges, offers feedback, and intervenes when the process falters. Facilitators, either as content or non-content experts, share a common responsibility to prompt students to think in ways similar to how practicing physicians think.

Perhaps a small group facilitators' time may be more productively spent in other pursuits more crucial to the academic mission (e.g., scientific research, patient care, etc.). This may be especially pertinent given competing interests for time and scarce

resources. Some suggest placing greater emphasis on clinical experts teaching in a more didactic manner<sup>1,2</sup> to increase instructional efficiency. Moreover, content experts who facilitate the small group case-based learning process<sup>3</sup> is preferred by students<sup>4</sup>. Likewise, it has been shown that non-content experts spend less time lecturing or discussing student knowledge deficiencies. However, they may enhance student self-directed learning opportunities<sup>5</sup>.

Therefore, it is important to facilitate well-managed learning groups to focus on learner-centered instruction. Skilled content or non-content experts are able to prevent and manage disruptive behavior. This is essential as we continue to effectively integrate the basic and clinical sciences for educating competent and proficient healthcare practitioners.

### Respondents

Students, what should students do if disruptive behaviors interfere with their learning? Faculty/Course Director, what steps are needed to correct an ineffective facilitator, when students complain about disruptive student behaviors?

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### Student Response

One of the biggest hindrances to learning is disruptive behavior by someone, no matter the setting. As a student, disruptive behaviors are a common occurrence that each student will more than likely experience at least once, if not several times, during the learning process. In the field of medicine—and academia—disruptive or inappropriate behaviors will happen, and students need to learn how to work and communicate with people who display such behaviors. Small group is the perfect setting to practice these communication skills with others.

The most appropriate initial course of action a student should take if a peer has disruptive behavior is to confront that person. The confrontation may occur privately or immediately after the disruptive behavior happens. The influence of a peer on changing behavior is greater than most can imagine; often greater than that of an authority. A student should express any concerns immediately, and often other students will echo the same concerns. If this is uncomfortable, the student can privately ask the disruptor to refrain from the disruptive behavior.

Often, no other interventions are necessary. However, if they are, then it might be time to seek an authority figure; in this case, the facilitator. Not only should concerns be raised with the facilitator, but also possible solutions to the problem. For example, readdressing small group ground rules or conduct guidelines would alleviate many difficulties.

### Faculty Response

While expressing willingness to lead a small group, Dr. Azuma clearly is uncomfortable with, and skeptical of, this format. Moreover, it appears that "willingness" means that he did not strongly object to this assignment and not that he sought it out. The first issue, then, is "How does one obtain 'buy-in' from faculty participating in small group teaching?" Many medical school faculty view themselves as, primarily, research scientists. Moreover, most faculty are familiar with a lecture format, having been exposed to it in their own training, while fewer have participated in well-run small groups. The 'fixes' are complex. At the institutional level, teaching efforts must be seen to contribute substantially to professional advancement. Training for group leaders may need to be made formal and mandatory, in which case, this training time must be counted as teaching time. If the teaching faculty are not the ones making the decision to pursue a small group

approach, then it becomes essential that the reasons for this decision be made clear. Data supporting the efficacy of this method may help to bring skeptical faculty on board. Discussion of the pros and cons of the approach, with full acknowledgement of the drawbacks, may help to draw in less enthusiastic faculty who might perceive this as a new challenge to be met rather than a new burden to bear.

A second issue is “How does a Course Director deal, at mid-course, with an ineffective facilitator?” The Course Director’s response, as presented, would be excellent under most circumstances and covers all major suggestions I might have considered. The behavior of the ineffective facilitator (Dr. Azuma) suggests a complete lack of knowledge of how a well-run group functions, rather than a complete lack of interest. It also leaves open the possibility that Dr. Azuma is uncomfortable in the role of an authority figure who must confront the disruptive student. Assuming that Dr. Azuma continues to express willingness to lead a small group, the Course Director’s response expresses appreciation while making it clear that his effort is falling short of the required standard and that it must be improved. Unfortunately, quite a bit of damage has already been done here: [1] it is already established in his group that the facilitator does not actually value small group activities and [2] a pattern of disruption has become the norm. The students now know that their facilitator does not support (or understand) what they are trying to accomplish in a small group setting, even if the disruptive behavior is removed. Under these circumstances, the Course Director owes it to the students to replace the facilitator in this group. Given that it will be problematic to locate a new facilitator, the Course Director could elect to rotate faculty among small groups. Since Dr. Azuma failed to attend the four hour training program, he could be required to co-facilitate four carefully selected groups for some on-the-job training prior to taking a group alone again. This is more supportive of Dr. Azuma than removing him completely from the course and offers him the opportunity to grow to become a valuable facilitator in subsequent years.

Another issue relates directly to the disruptive student. Some emphasis in any small group exercise should be placed upon the listening skills that a good clinician needs to develop. It should also be made clear that there is an expectation of professional behavior and an understanding of what that entails. To ensure some level of standardization between groups, the Course Director could institute a brief on-line activity, required of all students at the beginning of the course, which would clarify basic expectations

and criteria that will be used in student evaluations. It would then be appropriate for the Course Director to take the disruptive student aside and make it clear that he is in danger of receiving a poor evaluation.

A final issue relates to the question of cell phones in the classroom. Under rare circumstances, a student or faculty member may need to accept a phone call during a class. This should be made clear at the beginning of that class period and the call should be taken outside of the classroom. Under no circumstances should a personal call ever be permitted to be taken in the classroom. The same rules hold for texting. It is a good idea to pull out one’s own phone at the beginning of class, turn it off, and request that everyone else do the same.

### **Administrator Response**

A legitimate title for this case study could also have been “The case of the ineffective facilitator: A small group learner’s nightmare”, or perhaps “The case of the dysfunctional small group: A course director’s nightmare”. It could even be called “The case of the disgruntled faculty member: A department chair’s nightmare.” The case illuminates a number of system based issues that are all too frequently seen as roles and responsibilities at all levels of the academic enterprise collide.

Sadly, Dr. Azuma’s small group was doomed to dysfunction from the start through a cascade of events. While Dr. Azuma was willing to carry out the assignment of his department chair, he was not committed to success, as evidenced by his failure to attend the facilitator training session and his underlying lack of belief in the value of case based instruction. Small group teaching in a problem based format is a well established means of actively engaging learners, but the success of the encounter is dependent upon a committed facilitator skilled in leading small groups. Equally important to achieving the educational goals of small group encounters are learners who are prepared for the session and clear about the learning objectives and the expectations of the facilitator. A small group facilitator’s ineffective behavior can be as disruptive to the learning environment as a student’s inappropriate behavior; both serve as barriers to achieving educational goals. Dr. Azuma could have had a very different learning environment had he set a positive tone in the beginning, set clear expectations and provided timely constructive feedback when the student was being disruptive.

The overall success of a course is, in turn, dependent upon the success of its parts. If small group instruction is an integral part of a course, a dysfunctional small group could jeopardize the goals of the course. In this case, the course director had a responsibility to ensure that all small group facilitators were prepared for the task, requiring the training to be mandatory. It is now the responsibility of the course director to step in at this point and either rehabilitate the facilitator through faculty development or replace him.

At the level of the department and the school, faculty should have input in negotiating their work assignments with the department chair. Chairs should tap into the unique talents of each of their faculty and assign their work in a way that best achieves the overall missions of the school. Faculty with a teaching work assignment should participate in faculty development activities that enhance their teaching and the quality of their teaching should be assessed as part of their annual merit evaluations.

In this case, with the appropriate intervention, the disruptive student behavior and the ineffective facilitator's behavior has a good possibility of being modified, with the potential for a favorable outcome.

## **Respondents**

### Student Respondent

Eleanor A. Gradidge, MS2, University of Texas  
Medical Branch, Galveston, TX USA

### Faculty Respondent

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University of Illinois College of Medicine at Urbana,  
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### Administrator Respondent

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# COMMENTARY

## Techniques for Effective Teaching of a Medical School Course on Biostatistics and Epidemiology

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### ABSTRACT

A medical school course on biostatistics and epidemiology can be effective and popular, as long as the concepts and applications needed by medical students are carefully addressed – and illustrated by vivid, clinically-relevant examples and demonstrations. The authors present their approach to teaching, and some specific techniques and teaching tips, based on more than two decades worth of experience during which they have developed a course praised by the students for clinical relevance.

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### INTRODUCTION

Faculty presenting curriculum in biostatistics and epidemiology (B&E) to medical students may initially feel that their task is quite a difficult one. After all, students come to medical school to become doctors, and the statistical material and population-based characteristics of B&E make these subjects unlikely candidates for pragmatic relevance to clinical practice, in the minds of some students. Also, many people do not see “statistics” as synonymous with “exciting,” and sometimes the teaching does little to help overcome this preconceived notion. Student attitudes and reactions are not the only barrier to the effective communication of B&E course material, however; faculty must be very accepting of the need to adapt their curriculum and presentation to reflect the settings in which their students will most likely be working, so that students come to see the material as practical and interesting.

This article presents the authors’ approach to teaching biostatistics and epidemiology based on more than two decades of experience, an approach which has resulted in a successful and popular course cited by the medical students for its clinical relevance. It is hoped that this advice will help colleagues, especially beginners, at other institutions.

### ADJUSTING TO THE AUDIENCE

Nothing matters more in the teaching of biostatistics and epidemiology in medical schools than a keen awareness of the needs of the audience. When biostatisticians or epidemiologists are running a B&E course for medical students, a common mistake is to fall back upon faculty experiences in courses taken in degree programs designed for the preparation of such specialists. It is not adequate to update the scientific content of introductory courses from B&E degree programs while leaving the orientation unchanged. A course aimed at medical students must be quite different from a course whose audience foresees careers in biostatistics and epidemiology. Even physicians with substantial coursework in these fields sometimes fall prey to the tendency to focus on matters of technical interest or non-clinical examples, forgetting that most physicians don’t have, want, or need their depth in this area.

At our institution decades ago, a course was given which presented a solid traditional systematic survey of introductory biostatistics and epidemiology, with detailed hand calculations or computer analyses performed by students for nearly every statistical method in the curriculum, and often-fictitious examples contrived to match the development of statistical topics. This was typical of medical school coursework in our field at the time. Such a course might be a suitable foundation for introductory students in a school of public health, who have more class hours, some pre-existing interest in B&E, and an expectation of further study beyond the

introductory level. We are well aware of this “cultural difference,” because we both teach M.P.H. students, in addition to our medical school students. We went on to change the medical school B&E course curriculum based on our belief that medical students should have a course that might be termed “What Every Physician Needs to Know About Biostatistics and Epidemiology” – which is actually rather different from what, say, M.P.H. candidates need to know. Remember, a minority of physicians will ever be responsible for using statistical packages to perform analyses during their careers in practice, and those who become part of a research team generally have statistically-sophisticated specialists to consult. On the other hand, all physicians need to be able to read and understand the presentation of statistics in articles, for example. Thus, our course exercises focus on real-world examples, almost exclusively excerpted from published literature, and involve discussion of why the statistical method was selected, and how it answers a clinical question.

## COURSE GOALS AND OBJECTIVES

Clear goals and objectives are an essential guide for faculty deciding how to teach a course. As mentioned above, the goals and objectives derive from the needs of our audience.

Key concepts of statistical inference, experimental design, and epidemiology together make up a modest yet essential part of the physician’s intellectual toolkit. A firm grasp of these areas improves the ability to assess the strength of the evidence for recommended treatments, and is important for a competent discussion of that evidence with patients. Moreover, a physician might be called upon to explain the epidemiological concepts behind herd immunity or public health interventions, for example, to people unfamiliar with such ideas.

Because of the importance of these topics in the career of the practicing physician, biostatistics and epidemiology are part of medical school curricula in the United States and Canada. The National Board of Medical Examiners indicates expected coverage of these topics in the USMLE Step 1 content list shown in the “Quantitative Methods” subheading at [www.nbme.org](http://www.nbme.org). We were guided by this NBME topics list in making our list of goals and objectives. We recommend that faculty periodically consult this topics list (or analogous lists in other licensing jurisdictions) in case of changes. Review books for licensing exams should also be consulted. While not necessarily authoritative summaries of statistics course curricula, some of these books reflect the recent experience of test-takers and provide insight into on-going changes in examination topics. A review book is not an appropriate source for a course outline, but if our students are ill-prepared for licensure then our efforts to train them have been inadequate by an important minimal standard. By reviewing USMLE topics as well as boards review books,

we have observed such specific changes over the years as the addition of box plots and Kaplan-Meier curves to the topics that should be covered. In addition, our reading of the current medical literature, our long experience with physician-collaborators, and informal feedback from alumni, all contribute to our understanding of the relative importance of various areas of statistics and epidemiology from the clinician’s viewpoint.

Our course has these key goals, as stated in the syllabus distributed to the students:

- “1. To promote an understanding of biological and random variability and how these are quantified; to promote an understanding of how statistical comparisons can be made despite these sources of variability using statistical tests, which serve as tools in clinical decision-making and in the interpretation of laboratory results.*
- 2. To acquaint students with key principles and methods of biostatistics and epidemiology that are important for the understanding of published studies and for the assessment of their strengths and weaknesses.”*

Based on these key goals, we developed and distribute the following specific course objectives:

- “1. As students read the literature, they should be able to interpret graphical or tabular representations of distributions of biological measurements or patient outcomes or characteristics, and make judgments about the associated probabilities.*
- 2. Students should be able to understand the meaning of evidence presented in a journal article in the form of confidence intervals or p-values.*
- 3. Students should be familiar with the uses and interpretation of some of the most common statistical tools that they will encounter in publications.*
- 4. Students should understand that published conclusions may be affected by errors due entirely to sampling fluctuation, and/or due to biases inherent in the design of a study or the sampling plan used.*
- 5. Students should understand the impact of patient characteristics on clinical laboratory results, and be able to do simple calculations concerning the variability in predictive value that would be associated with changing prevalence of disease or risk factors.*
- 6. Students should understand the principles of study design involved in epidemiological research and in clinical trials, and the strengths and weaknesses conferred by various designs.*
- 7. Students should be aware of the ethical issues surrounding studies on people in such contexts as epidemiological studies and clinical trials. (This is a rather limited objective: abuses of the past, such as the Tuskegee Study and Nazi medical experimentation, are used as heinous examples of uncontrolled power over human subjects, which motivates a brief discussion of the origins, purposes, and*

responsibilities of IRBs, ethics boards, and similar bodies around the world. In other words, students are made aware of IRB approval as an essential step in the conduct of clinical research, and the reasons for this requirement.)

8. Students should be aware of the importance of disease surveillance systems and their relationship to public health and clinical decision-making.
9. Students should be familiar with the steps taken in the investigation of an outbreak or epidemic.
10. Students should be familiar with some of the principal causes of death and be able to account for these patterns of mortality.”

Each class session has specific identifiable objectives indicating what the student should be able to do once the session is complete. Students tend to like this feature of the syllabus, because they can use it as a checklist when they review for exams.

## MATERIALS DISTRIBUTED

On the first day of class, a student manual is distributed, which contains the course schedule, including the objectives for each session. All the slides which will be shown in class are also distributed, sorted by session. There are some exceptions, due to copyright restrictions on particular images or the need to have students work through solutions “in real time” when problems are solved in class. The slides distributed in hard copy are available online at the course website as well. The hard-copy student manual also contains all the readings which can legally be duplicated; the student reading is largely journal articles which exemplify the statistical or epidemiological principles under discussion. The online version of the readings is provided in the form of links to the websites containing the articles and posted reading materials, whenever access is unrestricted or our library’s licensing agreement permits such linked access. There is also required reading material which we make available only online, such as information about John Snow’s investigation of a cholera epidemic ([http://courses.sph.unc.edu/john\\_snow/](http://courses.sph.unc.edu/john_snow/)), or the *British Medical Journal*’s comprehensive series on “Epidemiology for the Uninitiated” (<http://www.bmj.com/collections/epidem/epid.dtl>). The student manual also includes previous exams, so the students know what to expect, and can test their knowledge.

There is no required textbook to buy, in view of the plethora of websites providing background reading. It is true that students often want a more fully developed explanation of topics discussed in class than might be provided by their own notes or the slides, so we lend each student a copy of *Probability Without Equations: Concepts for Clinicians*<sup>1</sup> free of charge. The free loan avoids the conflict of interest that would be posed by a professor in our course requiring and profiting from his own book, and

allows us to provide a written exposition of topics at a pace and level that exactly matches many of the lectures. At other institutions, where this parallelism is not an issue, other books might be equally valuable. For example, two suitable, brief, well-written, and inexpensive books to use for such a course might be *Dawson’s Easy Interpretation of Biostatistics*<sup>2</sup> followed by *Gordis’ Epidemiology*.<sup>3</sup> In our class, we individually tailor additional reading for those few students who want additional material at a higher level.

## CLASS SESSIONS AND WORK EXPECTATIONS

The class schedule reflects about 50 hours of contact time for B&E, a number which has decreased just a bit over the years thanks to essential, consistent support from our university’s administrators. Their educational theories and expertise lead them to believe in the importance of these class hours, and also influenced the placement of the course in the curriculum. B&E is taught at the very end of the second year, after all other coursework has been completed. It was felt that this subject matter would be most relevant when students could foresee a need for it in the immediate future, with their clinical work in the offing. It is widely understood that residents, fellows, and attending physicians expect the students to read and explain articles, and such explanations include issues of study design and statistical significance.

The class sessions are divided between lectures and workshops, with a slight preponderance of lectures. Biostatistical topics are covered first, followed by epidemiological applications, but the division between the two types of material is not very strict. It is hard to learn either topic in isolation, and there is no reason to keep them rigidly separate. Incidentally, over the years we have sometimes put biostatistics first and sometimes epidemiology; student reaction to the order of topics is not strong and is very mixed, with perhaps a moderate preference for biostatistics first. We find the curriculum can work well in either order and have settled on doing biostatistics first because of faculty scheduling issues. In addition, topics seem to us a bit easier to develop in that order, and having epidemiology second allows students to pull up their grades if they are not satisfied with their mark in biostatistics. The reverse – countering a poor epidemiology grade with an outstanding performance in biostatistics – is less practical for many students.

Too much lecture can be stultifying, but lectures can be an effective and efficient way to explain statistical material which students are not likely to master on their own. For example, in our experience, more of our statistical novices are able to understand the principles and applications of logistic regression after a careful, well-practiced, and well-illustrated explanation than would be able to understand it by reading a textbook or website on their own. It is also highly unlikely for individuals or problem-solving teams to originate or derive a statistical test for a particular type of

data when given data to analyze independently as part of an exercise. But it is equally true that passively witnessing an explanation of an existing statistical test is a poor learning experience compared to the experience of determining how best to analyze a set of data, and deciding what conclusions to draw from it. So we use a paradigm for our class sessions in which, generally, the first half is a lecture used to explain a statistical or epidemiological principle, and the second half is a “workshop” in which the students solve a problem under our direction. For example, a lecture on sensitivity, specificity, and predictive value is followed by a workshop in which each row of students in a large auditorium receives a worksheet with the same sensitivity and specificity but differing population prevalence rates. Students are then asked whether the test would be useful in their patient population. Since positive and negative predictive values vary according to prevalence, and vary in opposite directions, this makes for a gradient in the answers, along the rows. The students come to realize that the differing prevalence rates give each row a different perspective, and they can remember this point without studying, just by recalling what went on in class. The class gets experience in actually calculating predictive values and in interpreting them, with the motivation being a clinical decision.

For certain topics, we use online work outside of class in lieu of a workshop. For example, the CDC offers fine simulations of investigations of outbreaks. We usually use the one found at <http://www2a.cdc.gov/epicasestudies/computerbased/botarg.htm> as a homework assignment that the students do at their convenience, rather than as a workshop, following the lecture on infectious disease outbreaks.

We think that student participation is the key to an interesting and effective in-person class session. Even the lecture part should involve many questions posed to the class, with excitement, energy, and humor: What hypotheses are suggested by this map of disease? Does it imply that our region is better than others? Does the difference in illness rates coincide with differences in rates of eating pizza? Would you be willing to take this medicine? Would you give it to the person next to you? Why or why not? (Hey, I thought he was your friend!) Would you use an ELISA test in an AIDS-free population? Why or why not? Instructors can develop the knack for making the lecture develop out of a guided dialog that gives the students a chance to think, play, and be a part of an entertaining and appealing session.

Instructors should also have attention-getting tricks and examples available to make topics vivid and fun whenever possible. For example, the topic of hypothesis testing can be engaging to students, if you carry out the published demonstration involving a two-headed coin<sup>4</sup>. When discussing the importance of examining mortality distributions, we present some in class and have the students guess the source of the particular distribution – correct answers have included the Titanic disaster and a

tsunami. Most of the workshops are reviews of published journal articles, and we do not give out the answers. The group has to develop them during the workshop time. One workshop involves review of an article presenting chi square and logistic regression results; another involves interpreting the beta coefficients and p-values of linear regression and correlation. Thus, from our experience we recommend a lecture explaining vividly how and why a method works, followed by a workshop where published results are presented based on that statistical method. The actual performance of calculations is secondary, although for some simple topics (e.g., chi-square, predictive values) it is a skill the students are expected to learn.

We would add that this approach requires a high energy and interest level on the part of the instructors. Selection of the course directors and participants must be uncompromising – for a successful course you cannot accept faculty whose presentations are monotonous. In addition, if the faculty running the course are academic biostatisticians and/or epidemiologists, it is a great help if guest speakers can be added who have experience as field epidemiologists. We are fortunate to have several former Epidemic Intelligence Service Officers from the Centers for Disease Control (CDC) as department members, and they give arresting lectures about their experiences, which the students enjoy very much.

In preparation for class sessions, students are expected to study the material from the previous day and come in with any questions they may have. (We have an open question period scheduled after each class, and students never feel that no one will help them. Some students come just to listen to other students’ questions and the responses.) In many cases, students are expected to read the articles or article excerpts before coming to the workshop. They are also expected to do a self-test quiz about half-way through the course, consisting of questions drawn from previous exams. They are told that their mark on this test is a good predictor of their mark on the actual exams, so that if they get a poor mark on this test, it indicates a need for extra help. We schedule class time for the administration and a thorough review of this exam; if they want to take it under exam conditions, they can do so.

The pace of any course with 175 students – a typical number for us – is inevitably unsatisfactory to some of them. If you teach to the upper echelons of the class, others will not assimilate the material, and you end up failing the latter group in both senses of the word “failure.” If you teach slowly enough to ensure that essentially everyone masters the material, some students are bored. We do not have the staff to teach several sections of the course for students varying in interest and preparation level. We feel that on balance, in a large and diverse class, it is better to bore the best students (who find the material easy) than to panic and inadequately prepare the students who find this material difficult. After all, everyone who has been admitted to medical school should potentially be able to master this material at a reasonable level of competence,

and indeed the national board exams require them to do so. Students who come in with extensive directly-relevant coursework are exempt from our course, and if they fall just short of the exemption requirements, or choose not to seek an exemption, then they simply have an easy experience with our course, which we do not see as a tremendous problem. (It should be noted that we do not take attendance.) We would rather focus on “teaching for mastery,” i.e., making sure that all students meet a certain minimal standard of understanding of the material, rather than run a course catering to the needs of the more advanced students.

## EVALUATION AND CONCLUSION

Student learning is evaluated by two written exams, one on biostatistics and one on epidemiology. The exams are mainly excerpts from journal articles, accompanied by multiple choice questions asking for conclusions about the study designs and statistical methods employed, and interpretive questions on confidence intervals, power, and other statistical issues. The students are asked to draw conclusions from the article excerpts, from which certain key passages have been excised. Calculations are rarely required on the exam, except for numerical examples involving simple tabular material such as chi square and predictive values.

It is important to offer a high-quality, appropriate exam. Before the exam, faculty proofread each other’s exam questions and independently check the answer keys. The examination is compared with the list of objectives distributed at the outset (see above), to confirm that evaluation is based on the list of things we expect students to be able to do. In this way we are meeting an LCME standard. In addition, our university administration periodically collects lists of competencies from all course directors and ensures that all LCME-mandated competencies are represented appropriately in the curriculum. In reaction to a few recent queries from our school’s faculty about the level and breadth of our course exams, the course director has circulated exams to faculty at other institutions, who confirmed the suitability of these tests. This process is useful in order to avoid the establishment of insular, idiosyncratic, or possibly outdated ideas about exam coverage in a small group of faculty members – a fresh “outsider’s” look at exams is a good idea. Similarly, it is also useful to examine the results of your students on the “Biostatistics and Epidemiology” segment of the USMLE Step 1 results, which are sent to medical school officials. In recent years our students’ results on the boards in our fields do match or exceed the national average.

Immediately after each exam we post the answer key in person and online, and in a classroom session we immediately answer questions about the reasoning by which the correct answer is derived. Typographical errors

or ambiguities are resolved at that time, with changes to the list of accepted answers if necessary.

In keeping with the policy of our medical school, the course is graded on a fail/pass/high pass/honors scale. The two exams are averaged, and marks above 70 are passing; marks in the 80s are “high pass” grades; and marks of 90 and above are “honors” grades.

The course itself is evaluated by peer review within the institution, which has been favorable, and by students, who must fill out the online course evaluation in order to view their course grade upon completion. The students rate the course highly. We typically get ratings above 4.5 on a scale of 1 to 5, in which 5 is the topmost score. More important than this “popularity contest” type of feedback are later survey results from students indicating that they felt we prepared them well for boards questions and also prepared them well for residency and clinical practice. The medical school administration conducts those surveys.

Perhaps the most gratifying feedback is the reply to the course evaluation item asking for a response to the statement, “The clinical relevance of the basic science material was clear.” Recent responses were “to a very high degree,” 88 students (55%); “to a considerable degree,” 56 students (35%); “to a moderate degree,” 10 students (6%); “to a small degree,” 4 students (3%); “hardly at all,” 1 student (<1%). This shows that the goal of making this material clinically relevant is eminently achievable. You simply have to make it clinically relevant by remaining acutely aware of the audience you are addressing, and by being mindful of the applications of B&E for that audience. Everything needed for a valuable and valued course proceeds from that awareness, such as the nature of the worked examples employed in workshops, and the “journal clippings” approach to the course examinations.

We have discovered that it can actually be fun to construct and deliver a medical school course on biostatistics and epidemiology. We hope that the descriptive material in this paper concerning our course is helpful to others who are about to embark on the task of teaching this subject in the medical school environment, and we would be happy to help others by answering any questions you may have about our experiences.

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# SHORT COMMUNICATION

## Change in Laptop Use Over 4 Years; an Indicative Study at Leiden Medical School

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### ABSTRACT

At the Leiden University Medical Center in the Netherlands, laptop computers were introduced in medical education starting September 2000. This introduction was performed bottom-up (at student level) at a time when the educational program and individual faculty members were not prepared for this innovation. In this article the authors studied the changes in student use and perceptions of laptop computers in the period 2001-2005. They found that faculty had to adapt their teaching styles and educational programs before the laptops could be used most efficiently. Also students needed some time to discover the benefits of the laptop. Currently, the use of laptop computers is well integrated into teaching and learning.

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The use of computer technology in medical education has increased enormously during the last decade. The use of computers in teaching and learning is common in many schools now, and a digital learning environment has become almost indispensable.<sup>1</sup> Computers in education provide opportunities for more efficient and effective learning, but are also of enormous value in preparing students for their professional lives after graduation. Computer literacy of students and teachers has increased so dramatically during the last decade that it is no longer a serious concern in most schools.<sup>2,3</sup>

Leiden University and its Medical School, both founded in 1575, are the oldest academic educational institutions in the Netherlands. The medical school is now part of the Leiden University Medical Center (LUMC), which also conducts patient care and biomedical research. The curriculum consists of six years of study, of which the last two years are clinical rotations. Each year 345 students enter Medical School and 65 students enter the School for Biomedical Sciences.

In 1999, a new student-centered and patient-oriented curriculum was introduced in the Medical School. In this

curriculum, less time is devoted to large-scale lectures and more time is spent in small-group discussion sessions and self study. As a result, individual search for information and presenting results into documents becomes important. In order to facilitate these activities, the board of the institution decided to introduce large-scale computer facilities for students. Until then, students could only access a large number of high-quality computer-based educational materials through institutional computer workstations, but had no access to any other computer or network facilities. Therefore, new computer facilities were created in the medical library, and complementary document printing on ten network printers across campus was introduced. A self-developed learning environment on the Internet was offered, which eventually became a natural stepping stone to Blackboard, the commercial learning environment used since 2003.

In September 2000, a laptop project was started as another tool to obtain the stated goals. Laptops were introduced in addition to the existing desktop computer facilities, resulting in a ubiquitous computing environment. Every first-year student was given the opportunity to purchase a laptop computer at a special discount of 50%. During the

first three years of this project, voluntarily participation was over 90%. Since 2003, students have been required to purchase a laptop from a provider of their own choosing, and, as a result, by 2005 almost every student at LUMC had a laptop. Exclusively for the student laptops, a wireless network environment was created at the most important educational sites on campus.

The board of the LUMC decided to switch to student laptop use for organizational as well as educational reasons.<sup>4,5</sup> The new curriculum and increasing student numbers forced the organization to increase the number of computer workstations drastically. Shortage of physical space in the hospital environment and the required new hardware and services both predicted high future costs. By supporting the students in buying their own laptop, costs for space and hardware were reduced enormously and system management was transferred from the organization to the student. Secondly, future physicians need competences on using computers, network facilities and (medical) software applications. The possession of a private laptop forces the students to learn these techniques more quickly and thoroughly. We believe that students will become more comfortable and computer literate using their own laptops rather than using only institutional computer workstations.

In this article, we describe the changes in student use and perceptions of laptop computers at LUMC in the period from 2001 to 2005. Data on laptop use were obtained by questionnaires. Finally, the results of this study are projected to the situation on computer use in the academic year 2007/2008.

The introduction of laptop computers in the curriculum at LUMC was a major change and we anticipated a great effect on the students and their education.<sup>6</sup> How often do students use the laptop and how do they use it? Did the curriculum change as a result of providing more computer facilities to students? If so, what were those changes? In order to answer these questions, a questionnaire consisting of 18 questions was developed covering topics such as application usage, help desk support, and educational value. Each question was scored on a five-point Likert scale (1 = never/disagree, 5 = very often/strongly agree). The questionnaire has been approved by the department chairs involved in this study.

The questionnaire was distributed in the spring of 2001 and in the spring of 2005 among all 410 first-year students in both Medical School and the School of Biomedical Sciences during one of the main lectures. All answers were administrated and scores were summarized. By comparing the results from both years, changes in computer use over a period of 4 years could be identified. The students who did

not have a laptop returned the questionnaire reporting this fact and without answering the 18 questions.

In 2001, 209 of 410 (51%) students filled out the questionnaire. Among those students, 14 reported not having a laptop (7%). In 2005, 207 of 410 (50%) students replied. Of these students 9 had not purchased a laptop (4%), although at that time the possession of a laptop for education was compulsory. In general those students indicated that they could perform educational tasks without a laptop or with their desktop computers at home. In the text of this article, the sum of percentages of students who indicated a Likert score from 3 to 5 ("mean" up to "very often/strongly agree") are presented as a single score. The results from the students in the Medical School and the School of Biomedical Sciences are presented as one score. Full details are summarized in Table 1.

The use of the laptop for personal as well as educational purposes increased substantially in four years time. In 2001, only 11% of the students indicated they used the laptop for educational activities. By 2005 the size of this group had increased to almost 55%. Even more students used the laptop for personal use with an increase from 37% to 73%. Location of use had also clearly changed. A large majority of students used the laptop mainly at home, ranging between 72% (2001) and 82% (2005). Only 25% of the participants indicated that they regularly brought the laptop to the medical center.

The use of a number of computer facilities showed hardly any difference or only some small increase in use over the four years. E-mail use increased from 78 to 84 percent, internet use from 81 to 93% and the use of computer-based education from 45 to 51%. Also the use of the laptop for Word was stable at close to 81%. Use of the laptop for assignments and group meetings clearly increased from 35 to 62% and 18 to 41%, respectively. Microsoft PowerPoint use increased from 8 to 23%. In 2005, 17% of the students indicated that they used laptops to contact faculty while only 9% did so in 2001.

Only some slight differences were found between the populations of students of Medical School and the School of Biomedical Sciences. The facilities Word, PowerPoint, Excel and computer-based education were used more intensively in the School of Biomedical Sciences.

Most students were satisfied with the technical helpdesk support offered at LUMC. In 2001, about 56% reported being satisfied with the hours the helpdesk was open and 70% felt that the helpdesk personnel were trained well enough to solve their technical problems. Both figures increased over four years to 80%.



TABLE 1: Results of the evaluation, in percentages.

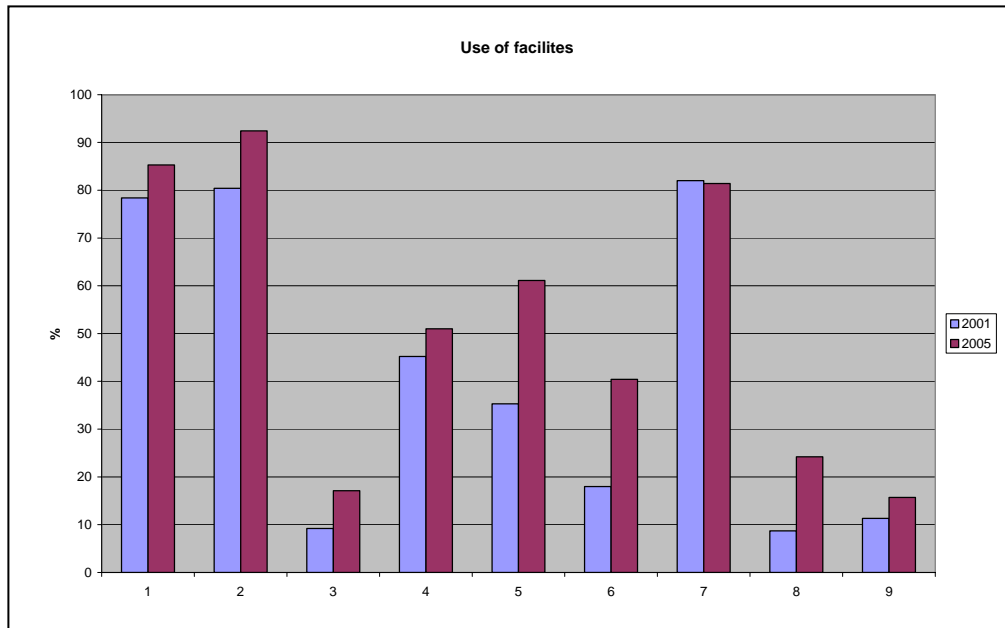
|  | 2001              | 2005     | 2001      | 2005 | 2001  | 2005 | 2001           | 2005 | 2001       | 2005 | 2001      | 2005 |
|--|-------------------|----------|-----------|------|-------|------|----------------|------|------------|------|-----------|------|
|  | Never             |          | Sometimes |      | Mean  |      | Often          |      | Very often |      | No answer |      |
| Use of laptop per week for education*                            | 57.4              | 21.7     | 31.3      | 23.7 | 6.2   | 29.3 | 2.6            | 13.6 | 2.1        | 11.6 | 0.4       | 0.1  |
| Use of laptop per week for private use*                          | 32.3              | 14.7     | 30.3      | 12.1 | 23.1  | 13.6 | 7.2            | 18.2 | 6.6        | 41.4 | 0.5       | 0.0  |
| I bring the laptop with me to the University                     | 45.6              | 34.3     | 33.3      | 37.9 | 20.0  | 19.7 | 0.0            | 4.6  | 0.0        | 0.5  | 1.1       | 3.0  |
| Use of laptop at home  | 11.3              | 6.1      | 15.9      | 8.1  | 29.2  | 10.1 | 28.2           | 25.2 | 14.9       | 47.0 | 0.5       | 3.5  |
| Use of the laptop for using e-mail                               | 9.7               | 4.0      | 11.8      | 10.1 | 22.0  | 13.6 | 34.4           | 30.3 | 22.0       | 41.4 | 0.1       | 0.6  |
| Use of the laptop for accessing the Internet                     | 8.7               | 2.0      | 10.3      | 4.0  | 20.5  | 11.6 | 37.9           | 30.8 | 22.0       | 51.0 | 0.6       | 0.6  |
| Use of the laptop for contact teachers                           | 52.3              | 36.9     | 36.9      | 38.9 | 7.7   | 12.6 | 1.0            | 4.5  | 0.5        | 0.0  | 1.6       | 7.1  |
| Use of the laptop for using CBE                                  | 33.3              | 11.6     | 20.5      | 33.3 | 23.1  | 35.4 | 14.9           | 12.1 | 7.2        | 3.5  | 1.0       | 4.1  |
| Use of the laptop for making assignments                         | 28.2              | 14.6     | 35.4      | 20.7 | 21.5  | 36.9 | 9.7            | 21.7 | 4.1        | 2.5  | 1.1       | 3.6  |
| Use of the laptop during small-group sessions                    | 54.9              | 16.2     | 26.2      | 38.9 | 14.4  | 30.8 | 3.1            | 8.6  | 0.5        | 1.0  | 0.9       | 4.5  |
| Use of the laptop for Microsoft Word                             | 6.6               | 6.1      | 10.7      | 9.6  | 25.1  | 26.8 | 39.0           | 35.4 | 17.9       | 19.2 | 0.7       | 2.9  |
| Use of the laptop for Microsoft PowerPoint                       | 65.1              | 42.4     | 22.6      | 27.3 | 5.6   | 12.6 | 2.6            | 9.1  | 0.5        | 2.5  | 3.6       | 6.1  |
| Use of the laptop for Microsoft Excel                            | 62.6              | 50.5     | 23.1      | 27.8 | 8.7   | 9.1  | 2.1            | 5.6  | 0.5        | 1.0  | 3.0       | 6.0  |
|  |                   |          |           |      |       |      |                |      |            |      |           |      |
|  | Strongly Disagree | Disagree | Mean      |      | Agree |      | Strongly agree |      | No answer  |      |           |      |
| I think a laptop is an advantage in education                    | 8.7               | 5.6      | 19.5      | 14.1 | 17.5  | 16.2 | 48.2           | 56.6 | 5.6        | 5.6  | 0.5       | 1.9  |
| I think a laptop will be indispensable in the future             | 9.7               | 3.5      | 18.0      | 26.8 | 28.2  | 18.7 | 35.4           | 43.9 | 8.7        | 5.6  | 0.0       | 1.5  |
| I would like to joint in E-learning from home                    | 11.3              | 16.2     | 16.4      | 34.3 | 6.7   | 8.6  | 44.6           | 29.8 | 21.0       | 9.1  | 0.0       | 2.0  |
| I am satisfied with the opening hours of the help desk           | 10.3              | 2.0      | 31.8      | 8.1  | 33.9  | 55.6 | 21.5           | 21.7 | 0.5        | 2.5  | 2.0       | 10.1 |
| I am satisfied with the professional assistance of the help desk | 7.2               | 4.0      | 19.0      | 6.6  | 35.9  | 49.0 | 33.3           | 29.3 | 2.6        | 2.0  | 2.0       | 9.1  |

Finally, students were asked about their own vision of the use of laptops in the future of medical education. Almost 80% of the students believed that laptops will be beneficial to education and will even be indispensable in the future. Surprisingly, the support for e-learning from home decreased drastically in 2005 (47%) in relation to 2001 (72%).

During the first measurement in the spring of 2001, laptops had been introduced as an educational tool as part of the curriculum at LUMC for only eight months. Faculty members at that time were not fully prepared for the introduction of this new technology, and consequently students were very unsatisfied about the fact the laptop

was not well integrated into the curriculum. This explains the low scores they gave on their general use of the device. Four years later, faculty had adapted their educational programs in favor of more laptop use. This resulted in a clear increase of laptop use for assignments and group work. In the small-group sessions, presentations are commonly used to inform group members of each others' homework. This explains the reported increase in general educational use of laptops in 2005 and the increased use of PowerPoint. These figures clearly show that achieving success in integrating a new device or technology into the curriculum strongly depends on the way faculties accept and use it. The fact that a few computer facilities are just used a little more in the School of Biomedical Sciences

FIGURE 1: Use of computer facilities at Leiden University Medical Center



Legend: 1=e-mail, 2=Internet, 3=contact with faculty, 4=computer-based education, 5=assignments, 6=group meetings, 7=Word, 8=PowerPoint, 9=Excel

can be explained by a slightly different concept of curriculum.

The small increase in the use of the laptop for e-mail, Internet, computer-based education, and Word was expected and is not significant. Levels of usage were already quite high in 2001 and there was no reason to expect a spectacular increase in 2005. Students in 2001 came to Medical School with high levels of basic computer literacy.

Students are convinced that the computer will become significantly more important in education and even indispensable in the future for them as students and as professionals. This is in line with all other predictions about our future and the important role of technology in it. It is surprising, however, that students now do not support e-learning as much as they did four years ago. A possible explanation may be the fact that in 2001 the new curriculum was only in its second year. At that time, students and teachers were dissatisfied with many elements of the new educational program. As a result it might be possible that a lot of students preferred a new and exciting alternative like e-learning more than the traditional

curriculum. Four years later, the quality of the curriculum has been greatly enhanced after several quality processes and evaluations. As a result, students today may have come to appreciate the kind of patient-oriented education in Leiden much more than they did before, making e-learning lose some attractiveness. Further, for distance learning the physical distance between home and Medical School is not an important issue for most LUMC students, since the campus is centered inside the small town of Leiden where almost all students live.

Eight years after the introduction of laptops in education and after years of curriculum adaptation, laptops are currently quite well integrated into the medical curriculum. On campus, the mobile device is primarily used during small group meetings and practical instruction sessions. Students wirelessly access the internet to search for information needed. For many anatomy and pathology classes, teachers incorporate public databases with microscopy slides in their teaching. Students visit those sites themselves during sessions or at home. Presentations are prepared and presented using PowerPoint and data are processed using statistical software packages. At this point the laptop has become the standard tool for students and

teachers for working on their assignments. Starting 2007 the student laptops have also been used in a campus wide pilot investigation to implement an audience polling system to support interactive large group discussion sessions.<sup>7,8</sup>

At home the laptop is used by most students as replacement of a desktop workstation. Word processing and internet access are the major activities performed. An internal study of Leiden University in 2005 showed that over 80% of the students in Leiden used broadband internet facilities in their homes. The intense use of Blackboard for last minute announcements and file distribution has urged students to access the internet on a regular basis, at home as well as on campus. As a result the laptop has become indispensable during almost all major educational activities.

It takes time to fully incorporate any new technology into a curriculum. At our institution, faculty had to adapt their teaching styles and educational programs before the laptop computers could be used most efficiently. Students also needed some time to discover the benefits of the laptop. Laptops were eventually fully integrated into the curriculum. In general, students are quite computer literate when entering Medical School. Our data indicate that students at LUMC primarily use their laptops at home and they do not believe in a future with a lot of distance learning

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# Faculty and Student Attitudes Towards and Use of Technology in a Technology Enhanced Integrated Medical School Curriculum

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## ABSTRACT

Technology is increasingly used in medical education. This study describes student and faculty attitudes toward and use of tablet PCs, electronic textbooks, and video podcasts in a technology-enhanced integrated curriculum.

A survey concerning the use of technology was collected at the end of each semester for the graduating class of 2010. Faculty completed a technology survey at the middle and end of the second year. Analyses consisted of descriptive statistics and proportional analyses were used to determine significant differences.

Most students took lecture notes directly on the table PC with less than 3% using paper and pencil. The use of specialized note taking software dropped over time from 73% to 51%, while the use of Microsoft Word increased from 5% to 16%. Students that wrote notes directly on the tablet PC remained relatively constant, while those that typed increased from 38% to 60%. Podcasting of lectures was popular, but lecture attendance dropped over time. While student preference for electronic textbooks increased over time, most students would buy print or a combination of print and electronic textbooks. Most faculty reported that having computers in learning activities enhanced the learning process and indicated that the electronic textbooks were easy to integrate into their learning activities.

Students and faculty were generally satisfied with the technologies and the student use of the technologies changed over time. If technology can enhance the learning environment, then we should embrace it because our students have.

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## INTRODUCTION

Students come to medical school with increasing knowledge about technology. Most current medical students are part of what has been called the Net Generation, a cohort of young people born between 1982 and 1991 that have grown up with information and communication technology.<sup>1</sup> This cohort tends to use a computer daily, regularly goes online, and is active in online social networking websites. They also tend to be highly connected to their peer group, especially through

the use of mobile phones, Internet chat rooms, instant messaging, blogs, and wikis.<sup>1</sup>

Since current medical students tend to be more technologically savvy than their predecessors, they may learn in fundamentally different ways from previous generations. Oblinger and Oblinger<sup>2</sup> suggested that the Net Generation is more comfortable with multimedia environments, prefers to actively engage in tasks rather than merely reading about them, are avid users of technology, and expect immediate responses. They are achievement-oriented and prefer a clear learning outcome

to a task. They expect technology to be a part of their educational environment and expect their instructors to have the ability to utilize technology to enhance their learning.<sup>2</sup>

There has been considerable research on web-based or Internet-based learning in the health professions with recent reviews finding well over 200 published articles on the topic.<sup>3,4</sup> Although research comparing the effectiveness of Internet-based learning compared with non-Internet instructional methods has found varied results, a recent meta-analysis concluded that Internet-based instruction yields similar levels of learning as that of more traditional instructional methods.<sup>4,5</sup> Continued research on the impact of technology on learning is clearly important. However, the focus of this paper is on how students view and use technology in their learning.

A recent literature review of information and communication technologies in higher education suggested that technology fosters information presentation, provides for efficient assessment, can foster collaborative learning and that computer simulation can be helpful especially for novices.<sup>6</sup> Other studies have focused on student opinions. Several of these studies have reported that medical and nursing students are highly satisfied with podcasting (i.e., a digital recoding of the lecture that can be played back on a computer or portable player) of lectures<sup>7,8</sup> and actually prefer reviewing recorded lectures after the lecture rather than listening live to a simulcast lecture on a computer.<sup>7</sup> Billings-Gagliardi and Mazor<sup>9</sup> explored whether lecture attendance would change as a result of students having access to lecture materials electronically. They reported that access to electronic course material did not impact lecture attendance. Another study investigated the use of electronic books and tablet personal computers (PC) for content distribution and note taking in a dermatology course. Although students thought the electronic books were an effective way to distribute course material and for studying, they preferred to take notes on paper.<sup>10</sup>

The University of Kansas School of Medicine recently developed an integrated, technology-enhanced medical curriculum to begin to address the learning needs of the Net Generation. The curriculum is organized into system-based modules, rather than the traditional discipline-based courses, with lectures in the morning and interactive small groups, problem-based learning (PBL) groups and laboratories in the afternoon. The centerpiece of this new curriculum is the student requirement for a tablet PC upon matriculation. The lecture halls are equipped with both wired and wireless Internet access. The tablet PC includes a standard hard disk image, with Microsoft OneNote<sup>11</sup> and Agilix GoBinder<sup>12</sup> note taking software that allows students to type on the keyboard or write directly on the screen using a stylus and electronic ink. The note taking software also allows students to organize their own files and to search for any term that was typed, written or stored on the computer. This process lets students actively organize the material to enhance their studying and

learning styles. All lectures are saved in a video digital format that allows students to review the lecture on a PC or a portable player. All course content (e.g., objectives, slides, formative quizzes, grades, etc.) is provided in electronic form and can be accessed directly from a shared network drive or through the Angel learning management system<sup>13</sup> either on or off campus.

For online text and reference material, the library licensed the web-based AccessMedicine<sup>14</sup> suite for the entire medical center. The School of Medicine purchased additional electronic textbooks from Elsevier and from Lippincott, Williams and Wilkins as a 2-year pilot project for the medical students. These additional electronic textbooks were installed on each tablet PC hard drive and are accessed through the VitalSource reader.<sup>15</sup> Histopathology labs were conducted using the Aperio microscope-simulator system<sup>16</sup> that allows students to move around a scanned microscope image, zoom in and out, annotate, and save images, in order to create their own histopathology atlas. A computerized testing center was built to allow students to take exams electronically and provide immediate feedback concerning their exam performance. Finally, an enterprise-level dedicated electronic survey development system from Vovici<sup>17</sup> was purchased for curriculum and program evaluation.

The purpose of this project was to identify how students use the technologies in medical school, understand their attitudes towards the technologies, and to track changes in attitudes and usage of the technologies. Another purpose was to evaluate the attitudes of faculty toward the technologies and their opinion of the impact the technologies have on the learning activities in which they participated.

## MATERIALS AND METHODS

### Participants

The graduating class of 2010 and the faculty that instructed them were asked to participate in the curriculum evaluation project. There were a total of 181 students in the class, which was comprised of 53% males and 93% Caucasians. The average age was 25.92 years (SD = 4.40 years), with 66% being born between 1982 and 1991 and 82% born between 1980 and 1991. A total of 146 faculty participated in the instruction of the class of 2010 (e.g., lecturers, PBL facilitators, small group and laboratory leaders, etc.) and were asked to take part in this project.

### Procedures

An online survey asking students about their use and attitudes toward their tablet PCs, electronic textbooks, lecture podcasts and other technologies was collected at the end of each semester for the first two years of medical school, yielding 4 data collection points (i.e., Fall 2006, Spring 2007, Fall 2007, and Spring 2008). Faculty

completed the online survey at the end of the Fall 2007 and Spring 2008 semesters. Participation was voluntary for all surveys and all responses were completely anonymous. This project was reviewed and approved by the University Institutional Review Board.

### Surveys

The student survey was developed by a committee of medical educators, faculty and technology experts as part of a larger technology survey used to evaluate student opinions and use of the technology within the curriculum. Questions focused on ease of use, frequency of use, and how selected software and/or devices were used in the curriculum. Some questions were also concerned with preferences for electronic versus non-electronic methods, usefulness of the technologies, or how the technology impacted their behavior. The faculty survey was developed by the same committee and focused on faculty observations and opinions of the impact of students having computers in their lectures and small groups, and having access to podcasts of their lectures. In addition, the faculty survey asked about their preferences for electronic versus traditional methods for teaching purposes. All questions utilized either a 4- or 5-point Likert response scale. Since the items varied in response format and the survey is anonymous, it is difficult to get an adequate reliability estimate for the survey. As such, there is no reliability information available for the surveys.

### Analyses

Preliminary analyses included independent t-tests and chi-square analyses to check the representativeness of those students that responded to the surveys to those that did not respond. Additional analyses which consisted of descriptive statistics and proportional analyses were used to determine any significant differences. All analyses were conducted using SPSS 15.0<sup>18</sup> and Microsoft Excel 2003.<sup>19</sup>

## RESULTS

The response rates for the four data collection periods were 34% for Fall 2006, 43% for Spring 2007, 37% for Fall 2007, and 32% for Spring 2008. Preliminary analyses conducted separately for each data collection period comparing students that responded to the survey with those that did not, failed to demonstrate any significant differences between the groups in terms of ethnic make-up, performance as measured by semester grade point average and average age (all ps > 0.05). One gender difference was noted for the Spring 2008 semester with significantly more females responding than males. Assuming that the above characteristics are related to attitudes toward technology, the mostly non-significant findings suggest that the results for those that responded to the survey may generalize to the entire class. The response rate for the faculty survey was 52% for Fall 2007 and 39% for Spring 2008.

### Note Taking

Students: Students were asked to indicate their primary note taking preference. The options included; paper-&-pencil, GoBinder/OneNote, Microsoft Word, PowerPoint, Other. Across all semesters, the majority of respondents (51% or more) took notes on the tablet PC using specialized note taking software while less than 3% indicated using paper and pencil to take notes. The use of note taking software dropped significantly over time from a high of 73% in Fall 2006 to a low of 51% in Fall 2007 ( $z = 2.51, p = .01$ ) and 53% in Spring 2008 ( $z = 2.23, p = .03$ ), while the use of Microsoft Word significantly increased from about 5% in Fall 2006 and Spring 2007 to 16% in Fall 2007 ( $z = 2.78, p = .005$ ) and 15% in Spring 2008 ( $z = 2.45, p = .01$ ). The use of PowerPoint as a note taking tool varied between 20% and 30% across the semesters.

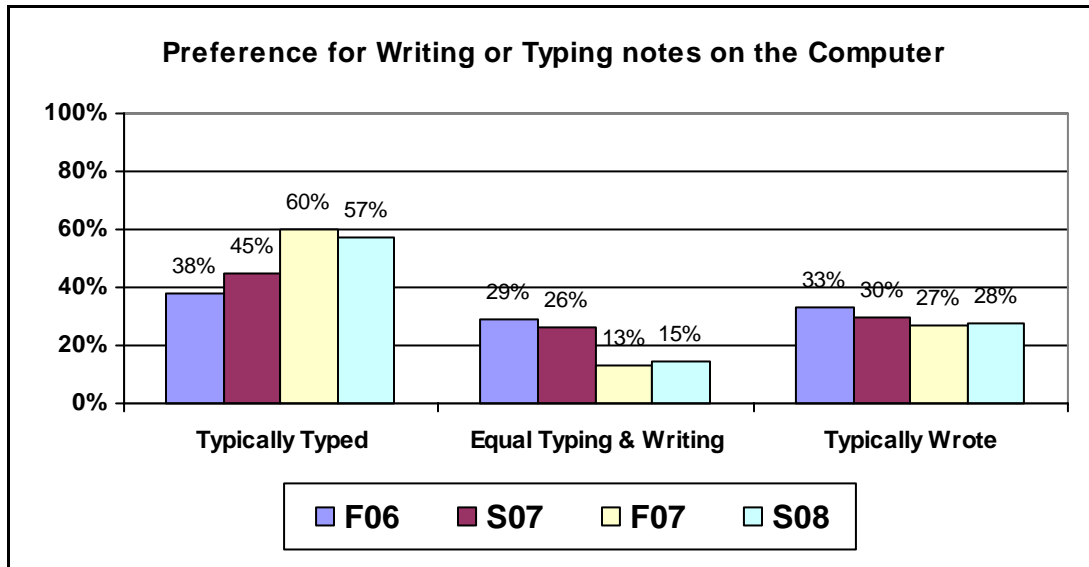
Students were asked to indicate their preference for writing on the tablet PC or typing on the tablet PC for lecture note taking with the following options; almost always typed, mostly typed with some writing, about equal typing & writing, mostly wrote with some typing, almost always wrote. Results for Fall 2006 indicated that 33% typically wrote on the computer using the stylus, 29% did about an equal amount of typing and writing on the tablet, and another 38% typically typed their notes. As shown in figure 1, as the class moved to the second year, (i.e., Fall 2007 semester) those that typically wrote on the computer remained about the same at around 30%; however, those that typed significantly increased from 38% (Fall 2006) to 60% (Fall 2007;  $z = 2.38, p = .02$ ) and 57% (Spring 2008;  $z = 2.06, p = .04$ ).

Faculty: Faculty were asked what impact the presence of tablet PCs in lectures, small groups and PBL groups had on the learning process with the following options: severely hindered, slightly hindered, no difference, slightly enhanced, significantly enhanced. About half (47% for Fall 2007 & 51% for Spring 2008) of the respondents indicated that having computers in their lectures slightly or significantly enhanced the learning process, while 19% during the Fall semester and 15% for the Spring thought it slightly or severely hindered it. For small group activities, 61% of the Fall respondents and 84% of the Spring faculty polled reported that having computers enhanced the learning process, while 17% or less thought computers hindered the learning process. Finally for PBL groups, about two-thirds of the respondents across both semesters noted that having computers in PBL enhanced the learning process, while 20% or less thought computers hindered the learning process in PBL groups for both semesters. No statistically significant differences between the two semesters were noted for the faculty ratings. Figure 2 presents these faculty data.

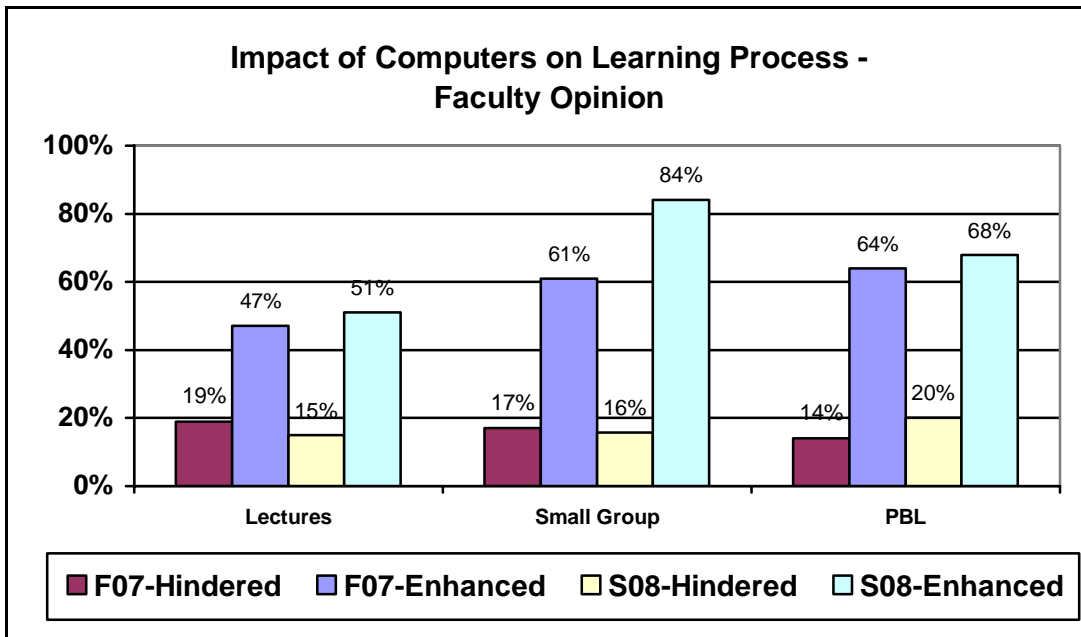
### Podcasting Lectures

Students: Students were asked how often they used video podcasts on a 5-point Likert scale ranging from never to

**Figure 1.** Preference for Writing or Typing Notes on the Tablet Computer.



**Figure 2.** Faculty opinion on the Impact of Computers in lecture, small group and PBL groups.



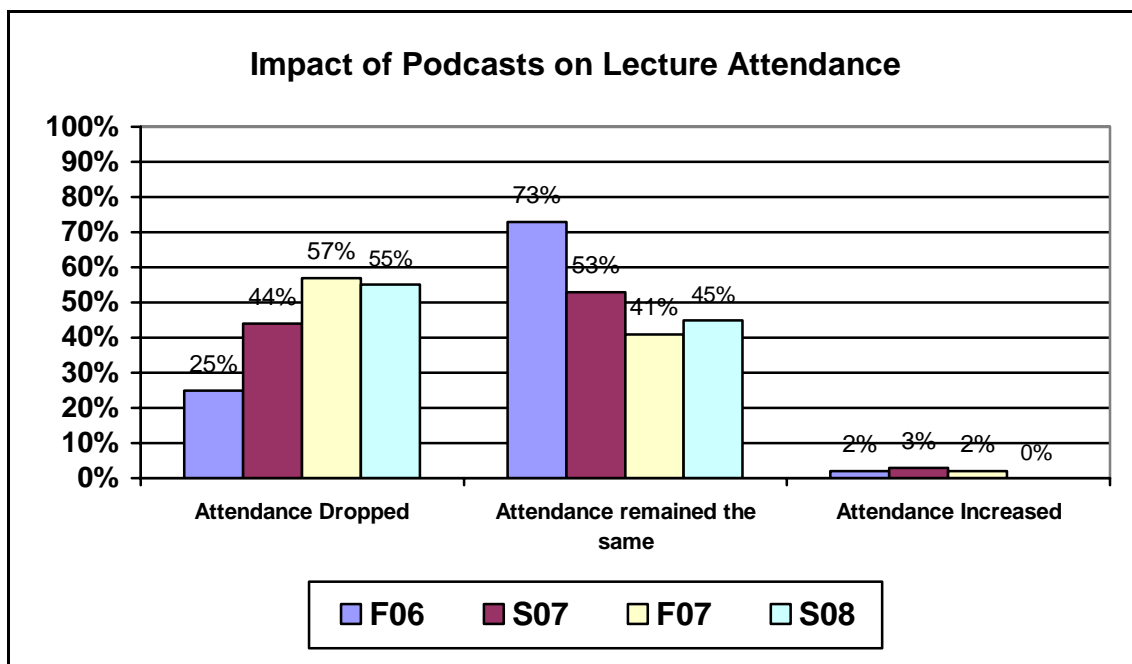
daily. Video lecture podcasts were popular with at least 58% of respondents indicating that they reviewed podcasts at least weekly across each semester. Only 5% or fewer indicated never reviewing a podcast. Students were also

pleased with the video podcasts as evidenced by 87% or more of the respondents reporting being satisfied or very satisfied with podcasts regardless of the semester in which they completed the survey.

Students were asked how podcasting impacted their lecture attendance on a 5-point Likert scale which was combined into three groups (i.e., dropped, remained the same, and increased) for analysis and are summarized in figure 3. Reported lecture attendance significantly dropped as students moved through their first year and into the second year of medical school. In Fall 2006, 25% indicated that their lecture attendance dropped as a result of reviewing podcasts and in Spring 2007, 44% noted a drop in lecture attendance and by Spring 2008, 55% reported that their lecture attendance had decreased (25% < 44%, 57%, & 55%; all ps < .05).

a 4-point Likert scale from strongly disagree to strongly agree. The majority of respondents (63% to over 90%) across the semesters agreed or strongly agreed that the web-based AccessMedicine electronic resources and VitalSource electronic textbooks were easy to use. In addition, ease of use increased as students used them overtime. Although the ease of use of the VitalSource textbooks increased over time, the percentage of respondents that reported using VitalSource textbooks at least weekly remained relatively constant over time at about 32% with a slight increase in Spring 2008 to 42%. Similarly, the percentage of student respondents that reported using AccessMedicine resources at least weekly remained relatively constant at about 32% over time with a

**Figure 3.** Impact of Podcasts on Lecture Attendance.



**Faculty:** Faculty were asked their level of agreement with the statement “Podcasting of lectures was valuable for students” on a 5-point Likert scale from strongly disagree to strongly agree. Across both semesters, 62% of the faculty polled agreed or strongly agreed that lecture podcasts were valuable for the students, while 6% disagreed or strongly disagreed. Thirty-three percent were neutral about the value of podcasting lectures.

**Electronic Textbooks**

**Students:** Students were asked about their level of agreement with the statement “AccessMedicine was easy to use” and “VitalSource etextbooks were easy to use” on

drop in use during Spring 2008 to 15%. Students preferred the VitalSource method of access to electronic textbooks over the web-based access of AccessMedicine (61% > 39%, p < .001). Significantly more respondents used AccessMedicine for quick reference as compared with the VitalSource electronic textbooks (67% > 53%, p = .006), while significantly more students used the VitalSource electronic textbooks for in-depth reading and studying (38% > 24%, p =.006). Finally, about 70% of respondents, regardless of semester, indicated that the ability to search electronic textbooks contributed to their use.



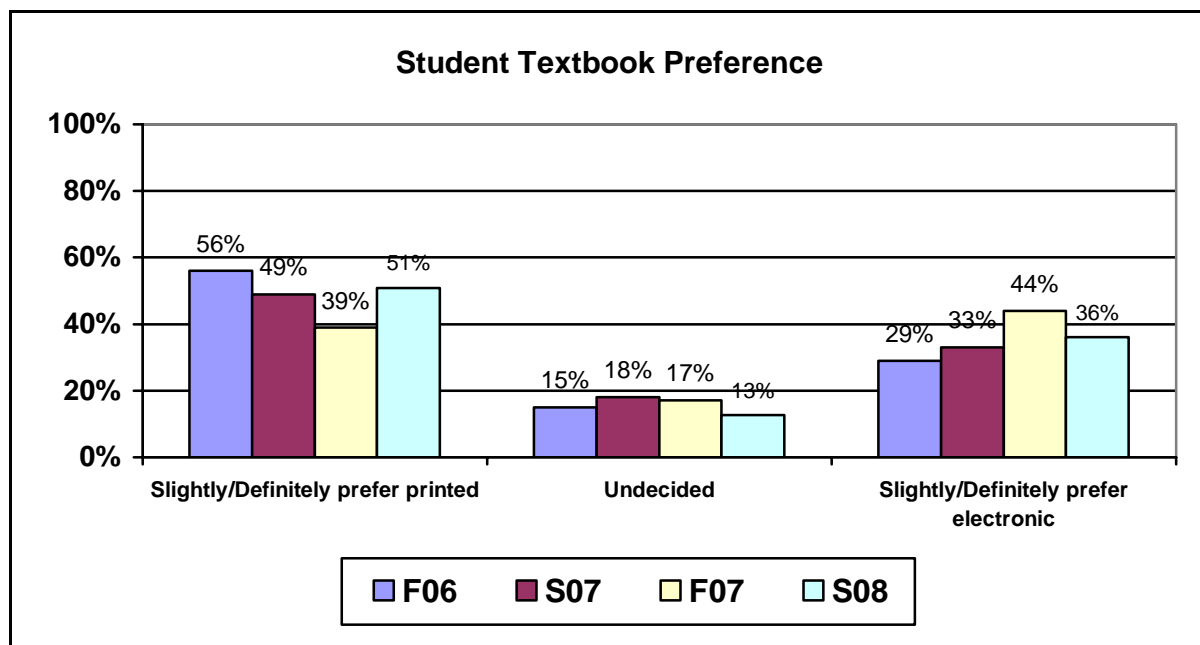
Students were asked if they bought or printed any electronic textbooks that were provided. Across all four semesters, 60% or more of the respondents indicated that they had not printed any textbooks. As concerns purchasing textbooks, only about 20% of respondents reported not buying printed versions of the provided electronic textbooks. The specific electronic textbooks purchased changed as students moved through the curriculum from pathology and anatomy books in the first year to embryology books in the second. Several students noted checking books out from the library or borrowing from upperclassmen rather than purchasing them. Reasons for not using electronic textbooks included technical problems that dropped from a high of 27% to under 14% by the second year, a preference for printed textbooks that varied from 25% to 43%, eye strain from reading too much on the computer, and needing a break from the computer, since it was used for everything in the curriculum.

Students were asked whether they preferred electronic over printed books, were undecided, or preferred printed over electronic books. Student preference for printed or electronic textbooks is presented in figure 4. Although their preference for printed textbooks dropped during the first three semesters 56% to 39%, the decrease was not significant ( $z = 1.87, p = .06$ ), and their preference for printed texts increased to 51% during the last semester. Similarly, student preference for electronic textbooks increased during the first three semesters 29% to 44%, but the increase was not significant ( $z = 1.72, p = .09$ ) and their

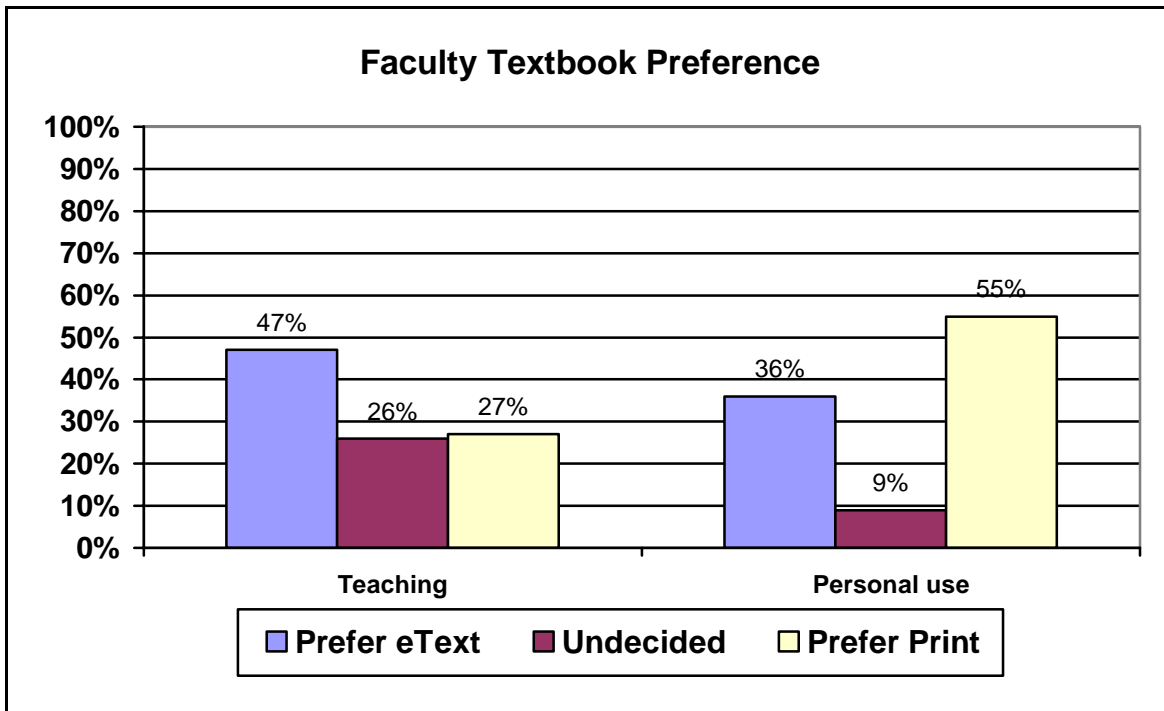
preference for electronic texts decreased to 36% during the last semester. Students were also asked if they had to buy textbooks today, would they purchase printed or electronic. During their first year of medical school, 40% to 47% of respondents would probably or definitely buy printed textbooks and during their second year 41% to 44% would still purchase printed textbooks. Purchasing electronic textbooks averaged about 15% across all semesters and approximately 40% of respondents across all semesters would purchase a combination of printed and electronic textbooks.

**Faculty:** Faculty were asked their level of agreement with the statement "Electronic textbooks were valuable for students" on a 5-point Likert scale from strongly disagree to strongly agree. The majority of respondents (59% for Fall 2007 & 57% for Spring 2008) agreed or strongly agreed that electronic textbooks were valuable for students with 12% or less disagreeing. A majority of faculty respondents (65%) across both semesters indicated that electronic textbooks were easy to integrate into their learning activities, while 18% disagreed. Faculty were also asked their preference for printed or electronic texts for teaching and personal use. Figure 5 provides the results for these questions. For teaching purposes, significantly more respondents across both semesters preferred electronic texts (47%) to printed textbooks (27%,  $z = 3.07, p = .002$ ). For personal use, significantly more respondents across both semesters preferred printed texts (55%) over electronic (36%;  $z = 2.68, p = .007$ ).

**Figure 4.** Student Textbook Preference.



**Figure 5.** Faculty Textbook Preference for Teaching and Personal Use.



**DISCUSSION**

Students readily accepted and used the technologies introduced by the curriculum, and their use of the technology tended to change as they became more experienced with it and with the increasing demands of medical school. Initially, the majority took notes on the computer using special note taking software, but over time many switched to taking lecture notes with Microsoft Word. Similarly, although most students took notes on the computer either writing, typing or in combination, over time, the majority of students typed their notes on the computer. These results conflict with those of Morton and colleagues<sup>10</sup> who reported that medical students preferred to take notes on paper. The differences between the two studies may account for the discrepant results. In the Morton *et al.*<sup>10</sup> study, students in one course volunteered to participate in a study that used computers and electronic textbooks. The authors stated that while many courses have web content, there was no centralized electronic course management system. Further, the electronic resources were introduced 1.5 years into the curriculum and only for one week. In our curriculum, all of the content for the first two years is digital. All students have the

Notes must be taken in some sort of electronic format if students want to be able to search their notes and easily integrate them with other content. Therefore, our curriculum structure strongly encouraged electronic note taking.

Podcasting of lectures was popular among students with only 5% never reviewing a podcast. However, students also indicated that one impact of the podcasting of lectures was a drop in attendance. Attendance decreased as students moved through their first year and into their second year of medical school. We have asked students about their lecture attendance for years without podcasts and from these previous surveys about 80% of first year students indicated attending most lectures, while only 59% of second years noted attending most lectures. Extrapolating the impact of podcasting on lecture attendance from these numbers suggested that the biggest drop occurred in the Spring semester of the first year with about 27% attending fewer lectures as a result of podcasts and about 16% of second year students attending less lectures because of podcasting. A drop of 1 in 4 students for first-year and 1 in 6 for second year suggests a relatively large impact of podcasting on lecture attendance. These findings are in contrast to previous research that did not report a meaningful change in attendance as a result of

students having access to electronic course material.<sup>9</sup> Because our findings are self-report only, additional research with accurate lecture attendance tracking is needed to better determine the impact of podcasts on lecture attendance and more importantly, performance in medical school.

In general, electronic textbooks were easy to use with ease of use increasing over time. Although ease of use increased with repeated access, frequency of use remained relatively stable over the two years. Students preferred the VitalSource textbooks stored on their computers over the web-based AccessMedicine textbooks. Students used the textbooks in different ways. The VitalSource textbooks tended to be used for more in-depth reading and studying, while the AccessMedicine web-based texts were used more frequently for quick reference.

The majority of students did not print paper copies of any of their electronic textbooks, but many did purchase printed versions. Although student preference for printed or electronic textbooks tended to change over time, there were no meaningful differences noted across the two years. At the end of the second year of medical school, the majority of students would either buy paper or a combination of paper and electronic textbooks. Technical problems, eye strain and needing a break from the computer were some of the reasons cited by students regarding their lack of use of electronic textbooks. Other comments revealed that previous use and comfort with traditional paper and pencil textbooks for studying and learning also limited the use of electronic textbooks. For the current class cohort, electronic textbooks were a nice option to have, but may not have been their first choice for learning. As students enter medical school with more experience with digital information and more experience with electronic textbooks, and as the technology improves, student preference for and purchase of electronic textbooks may likely change. To this end, longitudinal research tracking the use of electronic textbooks along with the advances in the electronic textbook technology should be conducted.

Since students were taking notes during lecture, the attitude of faculty towards having computers in class was also evaluated. Less than 20% of faculty polled for both semesters indicated that having computers in the classroom hindered the learning process. In fact, the majority of faculty polled reported that having computers in small group and problem-based learning activities enhanced the learning process. In addition, the majority of faculty respondents noted that podcasting of lectures and electronic textbooks were valuable for the students. Most faculty respondents indicated that the electronic textbooks were easy to integrate into their learning activities. Finally, for teaching purposes more faculty preferred electronic textbooks over printed, but for personal use more faculty preferred printed over electronic textbooks.

Although the majority of the faculty that responded indicated that the technologies enhanced the learning process, the exact nature of the enhancement is unknown since the question was designed to elicit overall general opinions. Therefore, it is also unknown what the “hindrances” may be to the learning process. Some of the “hindrance” to the learning process may be that the faculty tends to be less technology savvy than the students and did not use computers in the classroom when they were students and as such they may be resistant or reluctant to change. Nevertheless, additional research with more specific questions and focus groups may allow for more detailed explanations of these results.

These results must be interpreted in light of the limitations of this study. The sample consisted of one class from a single medical school and the response rates, although representative for the class, were relatively small. Therefore, these results may not generalize to other classes or other schools with different student demographics. As students enter with more technology experience, their views and use of technology may well be different from this cohort. The small response rate also suggests that only relatively large differences would emerge as significant. In addition, it is possible that those that responded were more technology-savvy than those that did not and this may have introduced some bias into the results. Another limitation is that the questions were written to elicit general opinions, so clear explanations for some of the results were not possible.

One reason for using the technologies was to better meet the needs of our students; however, the United States Medical Licensing Exam Step 1 scores for the class were no different from previous classes. It is difficult to determine exactly what impact the technologies may have had on Step 1 performance since many students also purchased and likely used printed texts to study and prepare for exams. Nevertheless, the integrated, technology enhanced curriculum at least did no harm to their overall learning of the material.

Although student and faculty opinions about the use of and satisfaction with technologies can provide useful information, the research needs to move forward to provide educators the knowledge of when to use technologies and how to use them effectively. E-learning research has demonstrated its effectiveness when compared to no intervention and similar effectiveness when compared to more traditional teaching methods.<sup>20</sup> Studies that determine the effectiveness of new technologies should be conducted for any new technology that may enter the medical education environment. In addition to the other studies already mentioned, qualitative studies may need to be conducted to better understand the use of electronic textbooks as compared to traditional textbooks for both faculty and students.

Overall, the tablet PCs, video podcasts and electronic textbooks were well received by both students and faculty

and the technology tended to enhance the learning environment. Based on feedback from students and faculty, plans for future classes include the use of tablet PCs, note taking software, a learning management system, virtual microscopy and podcasting. Students will continue to have access to web-based electronic textbooks through the library and will have the option to purchase electronic textbooks from publishers. Essentially these technologies have extended the learning space beyond the lecture hall, small group rooms, and laboratories by allowing students unlimited access to the material. Although the technology was well received, this current generation views technology as a tool to reach a desired outcome.<sup>2</sup> As such, technology should be used if it can enhance the learning of the educational objectives as was recently demonstrated in a course designed to enhance team processing skills.<sup>21</sup> As medical educators, we should be asking ourselves what we are doing to engage our students to develop the knowledge, critical thinking and reasoning, interpersonal communication skills, professional and ethical attitudes, and good judgment in evaluating and using online information necessary to become successful physicians. If current and emerging technologies can enhance the learning and acquisition of these important characteristics, then we should embrace them because our students have.

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