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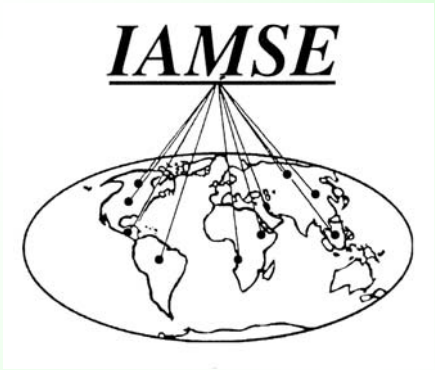





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# Message from Editor-in-Chief

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

Welcome to JIAMSE Volume 19-1

Hello everyone! This is the first issue of a four issue year. At the 12th annual meeting in Salt Lake City, it was decided to expand the Journal to four issues per year and include all types of publications in the volume, rather than separating according to Supplement material and regular volume publications. This will facilitate the documentation of your publications for your educator portfolios.

Volume 19-1 has a Letter to the Editor with a possible solution to the two Medical Education Cases Studies we have published earlier, two new innovations, four research articles, and a new Medical Education Case Study that will interest you. Let me remind you that "solutions" or your opinions on the Medical Education Case Studies can be sent to us, as Letters to the Editor, and will be peer reviewed. They count as a documentable publication. Let me also remind you to look toward your own teaching program and determine whether there is something innovative, successful, and perhaps unique to what you do and that might be of value to someone else who is teaching or even starting out in the education field. Such material can be written up and submitted to JIAMSE in one of our many possible formats for publication (see the website: www.iamse.org). With four volumes per year, the turnaround times will be relatively short and also, as always, our editorial policy is very user-friendly. I look forward to receiving your contributions.

All best,

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

# LETTER TO THE EDITOR

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I have read two of the medical cases in recent issues of JIAMSE which deal with examination question "security". Our experience at the University of Louisville, School of Medicine bears on this case.

For years our course in Medical Microbiology and Immunology released the examinations to the medical students. After many years, it became difficult to come up with new, relevant questions. Even in a dynamic field such as ours, it becomes hard to ask a question in new, valid ways. We would keep stems and change answers, or change stems for same answers. Anyway, this all became moot, when our school went to Block Testing. We run classes for five semester weeks, give the students four days free, and test them all day Friday of the sixth week on all the subjects presented in the five weeks (Streips, et al. JIAMSE, 2006, 16:10-18). The questions are scrambled and presented in 6 sections of 50 questions each. The test is carefully assembled, proofread, validated, integrated, and made as close to NBME type question sets, as possible. The test is also sequestered. Once they take it, the section is removed and the students don't see the test again until review. The test is only revealed with answers in a review session, where they can't take notes but can challenge questions. This allows them to discuss questions with peers and learn in that way, as well. However, with 300 questions it is impossible for them to pass on this test to next year students, aside from a question or two. We have a bank of questions which obviates this method as well. We have had no changes in success rates for questions in question analysis as long as we have done the examination process this way.

I feel we have the best of both worlds and the best answer for the cases proposed in the Journal. The students "see" the questions after taking the test, can discuss and learn, challenge answers, but cannot pass the question on to later classes. That way there is no copy of the exam floating around, which would be accessible to some people but not others. Also, students cannot study from our question set for the exams, but must study the material as they would for the USMLE Step 1.

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# INNOVATION

# Radiology CT Sessions as a Teaching Modality in Gross Anatomy for First-Year Medical Students

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**ABSTRACT**

This innovation is related to the integration of radiology sessions into a first-year basic science anatomy course. The authors used a Picture Archiving and Communication System (PACS) to provide computerized tomography (CT) radiology images that enhanced visual learning in anatomy and provided an interactive exchange among faculties and students.

In the last decade methods to enhance innovative modalities for the integration of curricula into advanced learning strategies have led to the acquisition of hardware and software programs that facilitate medical education. To a progressive and increasing extent, computer technology has been selected as an educational tool to instruct students in the many facets of radiology and anatomy. CD-ROMs and specialized websites have been widely used and accepted methods to enhance concepts of medical imaging and anatomical structure. Among the varied modalities, we employed an in-house Picture Archiving and Communication System (PACS) to provide clinical relevance to Gross Anatomy, a first-year basic science course. PACS was designed by AGFA, Inc., Mortsel, Belgium. Students, in groups of five, are rotated through mandatory teaching sessions in the Department of Radiology at Creighton University Medical Center. Each group, facilitated by a radiologist, reviews PACS images of a computerized tomography scan (CT) of their respective anatomical cadaver that are stored on a local server. Following each radiology session, the PACS system allows students to access and view their cadaver images from a remote computer laboratory in the School of Medicine. Each student group rotates through the radiology exercises in three separate learning sessions, which include the 1) abdomen, 2) chest and 3) head and neck. The learning sessions are preceded by a short 5-minute anatomical lecture to orient students to the respective radiological session. Additional large group format lectures are provided for each of the above sections. The current integration of radiology CT sessions provides a method for visual cues in anatomy and enhances the value of anatomical learning strategies. In addition, the sessions provide a format for the interactive exchange between clinical faculty and medical students and complement learning concepts in beginning radiology. Evaluation criteria provided course comments that were positive, including "The radiology sessions were really helpful, I would like to see more of them in the future to help assist with the anatomy learning requirements" and "The radiology sessions were a great introduction into radiology." This innovative approach provides a means for clinical faculty and residents to engage first-year medical students with a unique experience.

  

# INNOVATION

# A Creative Final Evaluation: Measuring Achievement in a First Year Patient Centered Medicine Course

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Student achievement in first year basic science courses is commonly measured with multiple choice examinations to assess knowledge acquisition. Measuring growth/achievement in "doctoring courses" is more challenging. The goals of our Patient Centered Medicine (PCM I) course include developing effective patient-doctor communication skills, learning to work as members of multi-disciplinary health care teams, and demonstrating knowledge of ethics, cultural competency, and medical economics. Course instruction includes large group activities (lectures, films, patient interviews), faculty facilitated small group activities (discussions and standardized patient encounters), and individual self-directed learning (readings, journal writing.) Faculty facilitators evaluate students weekly in small groups; an end-of-year OSCE evaluates communication skills. To assess the broader array of course competencies, we implemented a creative final course evaluation that is enjoyable for both students and faculty.

Each spring toward the end of PCM I, students collaborate in their small groups (10 -11 students) to select a health care system problem and potential solution, and to develop a 10 minute creative presentation (skit, song, poem, dance), to present to the whole class. Over the past two years, topics/themes have included improving the quality and safety of health care, complementary/alternative/integrative medicine, culturally competent care, ethical challenges in health care, and interfacing spirituality, religion, faith, and medicine. Faculty rate the presentations (2 = Excellent, 1 = Good, 0 = Fair/Poor) on the extent that acquisition of the course competencies is demonstrated, on evidence of working collaboratively, and on overall creativity.

Student evaluations of the final exercise have been overwhelmingly positive. Students enjoy the change of pace, collaborating with classmates, engaging in the project, and the satisfaction of having produced a good quality final presentation. Negative comments related to the project taking more time than expected, and to the difficulty in getting the group together for planning. Although there was some resistance in year one, the exercise now appears to be part of school "culture," an expectation for the end of PCM I and the M1 year. Faculty report that watching the performances is enjoyable, and an effective way for students to demonstrate growth and achievement in the Patient Centered Medicine course.

# MEDICAL EDUCATION CASE STUDY

# Between God and Man: A Student's Dilemma


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|---|---|---|



**ABSTRACT**

This case highlights the challenges both faculty and entering medical students face when faith-based practices collide with schedules. Specifically in this case, the faculty member ponders the balance between accommodation and avocation for an entering Muslim student attempting to maintain all religious holidays, fasts and prayer five times/day.


The first day of MS1 Principles of Clinical Medicine small groups, a respectful young man approached me to inform that he would be late each week because he needed to pray. He explained that his Muslim faith required he pray five times per day, and between the lecture and small group session was a time prayer needed to occur. I agreed. The weeks followed, and each week he would quickly drop his backpack off in the small group room, disappear for about ten minutes and discretely re-enter the room. The small group seemed ambivalent to his late arrival, yet we did not delay or repeat content. One time this resulted in this student not participating in an autogenic exercise, but generally he simply missed some of the early conversation related to the previous lecture.

Mid way through the term, the student respectfully emailed me to let me know he would miss school (and small group) the following day because it was a Muslim holiday. After that he wrote the following in his required reflections assignment:

> "I missed the last PCM, because of 'Eid Al-Fitr' which is one of two total Islamic holidays. It marks the end of the month of Ramadan and therefore, the end of a month of fasting from food and water during daylight hours. I found it sort of ironic that the topic of the PCM class that day was how to deal with stress while in school, and the different methods of stress release. This was ironic to me because I personally felt that adhering to my religious commitments serve as stress release. So, taking that day off from school to attend the traditional morning 'Eid' prayer was a manner of stress release.
>
> Furthermore, I felt that as a Muslim, there are periodic times of stress release throughout the day. I am referring to the five daily prayers that are obligatory upon Muslims to fulfill. These prayers are spread throughout the day and night and typically last from between 5 minutes to 10 minutes. They serve as moments of stress relief, because one of the intentions of prayer is not only to strengthen one's relationship with God, but also to detach themselves from this worldly life. In fact, the Prophet Muhammad (peace be upon him) told one of his companions to make the call for prayer so that we can be 'relieved from the stress of this world'. So I think that the idea of consistent prayer or meditation for others, helps incorporate mechanisms for people to deal with the stress that is in their lives."

Up until this point, this student has been the quietest in the group. His pale face and flat affect caused me to wonder if he was depressed. In the two sessions following this reflection paper (and the break of the fast of Ramadan), he has become animated, has a sense of humor, and is an active participant in the small group. He still arrives late each week. My dilemma as faculty and facilitator of the small group is how to advocate (or do I need to advocate?) for this student. Will every faculty accommodate his faith needs? What will happen when he does his surgery rotation or residency? What is my role as the first faculty to likely understand the depth of his faith commitment? Will medical education in our environment and his faith requirements result in a crisis of time versus values? Should I do nothing?

**Student Response**

Patients, physicians, medical students and their educators all must learn to negotiate the complicated intersections of the ideals of religious faith with the realities of medical practice. The student in this vignette is beginning to find his own path through these intersections, and there is little doubt he will face similar, likely more challenging dilemmas in the future.

As a clinical clerk in medical school, and as a member of a house staff team during residency, he may need to make adjustments to the strictness of his adherence to prayer times, or even to his manner of observing religious holidays. Most teams will not look kindly on requests to step out in the middle of a surgery, for example, to pray – especially if the patient is unstable. It is a matter for the student to discuss with himself, his family, his colleagues, his educators and his God, and I hope he can find a balance between prayer and clinical learning that is acceptable to all involved and allows him to provide excellent medical care.

This process of reconciling faith with medicine may not always be an easy one, and he may face insensitivity or even intolerance along the way. I am pleased that the author of this case is so sensitive to the student's situation and is ready to advocate on his behalf. I think, however, that unless the student was to face an academic misunderstanding or obvious intolerance as a result of his religious practice, it is up to the student to look out for himself. The case author has already participated in the student's growth in a meaningful way by providing a safe forum for him to reflect on his faith.

If the author would like to engage more fully with these issues, perhaps she or he could look into what the medical school official policies are with regards to the religious observances of students and residents, and investigate just how departments have handled such dilemmas in the past. In addition, it would be of value to examine the completeness of the school curriculum in its teaching about the many challenging intersections of faith and medicine.

**Faculty Response**

In response to the question regarding faculty advocacy I would say, yes, you need to advocate or educate the student as a faculty and facilitator of the small group.

Thinking about the question about the student's situation during surgery rotation I would say that flexibility is needed. Once in a while we can accommodate his faith needs like - by allowing two restricted holidays in a year in order to fulfill his faith needs and definitely no faculty will accommodate his faith needs as you did in this particular case.

Response to questions about the responsibilities of the faculty member and the school to the student's faith requirements - As the first faculty to face such types of problem you should be very clear with the rules and regulations of the academic institution and you should be in a position to explain the importance of the academics, you should help the student to realize the importance of that particular task if he misses that class / small group discussion. You should explain to the student clearly that he should not interlink the faith needs with academics and being a responsible faculty / academician we should not entertain such type of activities inside the academic institution and if we do so it will give a wrong message to the other students of the small group and the activity flourishes which leads to the collapse of the discipline and integrity of the students.

You should understand that the student needs some kind of help and support in such type of situations / circumstances. You can achieve this by ***Academic Counseling***.

Academic counseling includes Information, Advice and Counseling.

a) Information is about knowledge, which is largely independent of the student. Rules, Regulations, and similar things need to be informed. You need appropriate knowledge and communicating ability to be able to inform.
b) Counseling is letting the student decide for himself as to what is best for him regarding the choice of career and other points which need one path to choose out of many available. This is an entirely student dependent activity.
c) Advising is a mixture of the two – after clarifying the need, you offer several options, but recommend only one, especially for that particular student.

As a faculty of a medical institution I have faced the similar problem with some of the students regarding their faith needs. But immediately I counseled the students and made them to understand the consequences of the activity and I made them to realize the importance of the

academics (that is if they miss one class they will not have the continuity to the next class and it continues till the end of that chapter or the topic). Also I tried to explain the consequences if I give special permission to them in regard to the relation with the other students.

Finally it depends purely on rules and regulations of the medical institution since we have to work under the influence of the Dean or Principal of the medical institution.

**Administrator Response**

This case illustrates the challenge that students and institutions often face when navigating the complexities of special accommodations. While the title designates it as "a student's dilemma", it also becomes an institutional dilemma. Every institution has technical standards that it must adhere to in order to confer that its graduates have mastered the academic and clinical demands and the educational competencies required for residency and the ultimate practice of medicine. All students, including those who have special needs due to their personal religious beliefs or personal health issues must still meet the technical standards set forth by the institution.

It is standard for academic institutions to have policies that address observation of religious holidays. Students whose religious faith requires accommodations beyond those that are set forth in the existing policies should be proactive and request special accommodations at the time of matriculation. Proactively, a conversation between the student and the officers of the school, particularly Student Affairs, Medical Education and Academic Affairs should take place and the student's needs will be fully explored, including the specific details of the accommodations requested. The school will then make a determination as to whether the student's accommodation requests can be met and whether the accommodation compromises the student's educational experience. In this case, it does not appear that this conversation took place; rather the student assumed that he was entitled to these accommodations. While the faculty member in question showed a great deal of sensitivity toward the student in wanting to advocate on his behalf, the issue is an institutional one and not just a student/faculty issue.

The student needs to balance the needs of his own religious faith with the needs of his patients and the requirements of the education to prepare him to care for patients. Accommodations that require frequent absences and the inevitable interruption in his education may be easy to accomplish in some situations, for example, missed lectures where technology allows the student to review the lecture later. In other situations, such as small group learning where participation is key to learning, or the clinical arena, where continuity of care is at stake, this becomes far more difficult, and in all likelihood, the student may need to identify activities that are core to his faith and see if there is any flexibility in the timing of his observances. Regarding his prayers as a means to be "relieved of stress of this world", there may be times during the day or night that this can be accomplished that would not interrupt the integrity of his medical education. Stress relief is important for all students, and the student can be counseled on additional ways of relieving stress and coping strategies in addition to prayer.

Resolution of this issue requires a broad-based discussion between the student, a faculty advocate and key administrative officials. The discussion and ultimate decision regarding the requested accommodations should balance the personal needs of the student with the technical standards of the educational program. As part of that discussion, all parties should explore where there is flexibility within the confines of the curriculum and where there is flexibility within the confines of the student's faith. In certain clinical situations, continuity of care may preclude the ability of a student to be absent at set times during the day, just as it would be for residents and practicing physicians. Where there is flexibility, however, an effort should be made to provide reasonable accommodations.

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# Students as Teachers and Course Designers: Renovation of an Introductory Pathology Course

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**ABSTRACT**

The field of medicine requires a lifelong commitment to education, both as a student and as a teacher. The role of medical students in teaching as well as course design has seldom been explored. As part of a curriculum change at our institution, senior medical students were integrally involved in designing, implementing, and teaching a new first year pathology course focused on independent learning. Before the 2006-2007 and 2007-2008 pathology course, the course director chose four to five senior medical students to act as teaching assistants (TAs). TAs met with the course director multiple times to discuss new course components. Due directly to involvement of the TAs, the 2007-2008 pathology course consisted of five components: lectures, small group sessions, journal club sessions, podcasts, and student case presentations. After the 2007-2008 pathology course, 41 of 42 students completed a subjective survey assessing the course as well as the use of senior medical students as TAs.

This study documents senior students operating effectively as both teachers and course designers. It also serves as a blueprint for student course designers to implement and evaluate changes and foster a culture of peer teaching. It demonstrates that first year medical students are comfortable with senior medical students as teachers; furthermore, these students have an increased interest in teaching as a result of the course. This involvement of senior medical students in the teaching and course design process may foster a culture of peer teaching and leadership that would benefit medical students, their peers, and potentially their patients.

## INTRODUCTION

Medical education is a constantly evolving discipline. This has been illustrated in the last three decades, during which trends in education methods have moved away from lengthy lectures toward problem-based learning (PBL) and more recently, team-based learning (TBL)[1-3]. In the case of PBL and TBL, studies have demonstrated improved student attention, comprehension, and enjoyment[4,5]. These positive results have led to the widespread adoption of these methods in medical school curricula across the country. Broad changes in teaching ideology are generally implemented from the top down; however, at every institution these tools must be refined to fit specific student and classroom needs. Quality improvement (QI) initiatives and 360 degree evaluations attempt to evaluate individual courses in order to improve teaching methodology on a classroom level, but changes are often either too small or too slowly implemented to be of benefit.

Although the Accreditation Council for Graduate Medical Education (ACGME) recognizes the critical role of residents

as educators for both graduate and undergraduate medical education, there have been relatively few studies that describe how undergraduate medical students develop skills that are critical for their development as educators[6]. At almost all medical schools, students play a significant role in the evaluation of courses and clerkships. However, their role is often a passive one, restricted to filling out critiques addressing faculty identified strengths and weaknesses of the curriculum. In spite of this, medical students who have recently completed the course are often in the best position to identify the most efficient methods to facilitate learning of the material. Direct involvement of students gives the potential to swiftly design and implement changes specifically desired by students. Engaging in the process of curriculum reform requires students to reflect on current limitations and potential areas of improvement, formulate a plan, and act on that plan. Thus in addition to improving existing courses, this process cultivates leadership skills.

Our institution recently restructured and revamped the first two years of the medical school curriculum, implementing student-directed and team-based learning ideas from PBL and TBL formats. The curricular changes also aim to better prepare students for the challenges of 21st century medicine. Inherent in these changes is the vision that medical students will become effective leaders and team members who improve processes, improve outcomes, and think creatively to advance medicine through innovation and education. With this in mind, we provided senior medical students with the opportunity to develop and implement several novel learning techniques in a cell biology and pathology course taught to first year medical students.

Nine senior medical students restructured the first year cell biology and pathology course. The result was a hybrid format of high-yield lectures and small-group learning sessions. In addition, several initiatives were developed by third year students to provide first year students with additional learning tools. Development of learning tools took into consideration many different learning styles[7], which were divided into three broad categories: auditory, visual, and kinesthetic. To appeal to these major learning styles we included a twice weekly podcast review, a biweekly clinical journal club, and student case presentations. These teaching tools have been widely used and studied in the past. Podcasts have been used by medical journals to report weekly news to medical personnel, by major medical centers to educate a general audience, and by educational centers for continuing medical education[8-10]. More recently, the use of podcasts in the classroom has been studied, and well received by medical students without any decrease in class attendance[11]. Similarly, journal clubs have been widely used in residencies to teach skills in clinical data interpretation[12].

Here we report the renovation and evaluation of an introductory pathology course at Mayo Medical School executed primarily by medical students, with teaching responsibilities shared between senior medical students and faculty.

## METHODS

*Selection of Teaching Assistants*

Before the 2006-2007 and 2007-2008 academic years, the course director for the first year Pathology and Cell Biology course selected four or five interested medical students in the clinical years (years 3 and 4) to act as teaching assistants. Teaching assistants (TAs) planned their clinical schedules such that teaching time overlapped with research time, protected from clinical responsibilities. A twelve week research block is included in our institution's third year schedule.

TAs formed a committee before the course began to develop methods to reduce contact hours, increase learner autonomy, and provide students with appropriate tools to allow them to efficiently and effectively learn pathology. TAs then met with the course director to discuss implementation of new ideas, and together developed the course schedule for the academic year.

*Pathology and Cell Biology 2006-2008*

From 2006-2008, the Pathology and Cell Biology course at Mayo Clinic College of Medicine was trimmed from a twelve week to a six week long course. The course covers cellular homeostasis and reactions to stimuli that disrupt homeostasis and lead to disease. Specific topics include homeostasis, intracellular accumulation, necrosis, inflammation, hemostasis and hemodynamics, and neoplasia. Approximately forty-two students enroll in the course each year. Six to eight hours per week of lectures are conducted by the course director, decreased significantly from ten hours per week in previous years.

*Small group laboratory sessions*

Previous iterations of the Pathology and Cell Biology course included weekly laboratory sessions, which allowed students to work independently through microscopic slides and question sets in order to apply principles learned in class to both gross and microscopic specimens.

For the 2006-2007 and 2007-2008 academic years, these independent laboratory sessions were replaced by twice weekly small group sessions designed by medical student teaching assistants. Students were divided into groups of ten to eleven, with each group led by a senior medical student-teacher. These sessions consisted of a brief overview presentation followed by three to four clinical cases with correlating microscopic and gross specimens. Sessions covered gross and microscopic changes as well as laboratory and clinical findings. Each case incorporated a clinical history, gross specimens, virtual microscopy (presented on

classroom smartboards and individual laptops), and questions for discussion. Topics, cases, images, PowerPoint slides, and questions for each small group session were selected by the course director and were common to all small groups. Student-teachers met 2 to 5 days before sessions to discuss the questions, important concepts, and clinical correlations to ensure homogeneity of small group sessions. The course director was available when questions among TAs arose. Prior to each session students were provided with the clinical history and discussion questions. Students were encouraged to review the case in order to allow for efficient learning. Students worked in groups facilitated by the student-teacher, who was responsible for ensuring that major teaching points were covered. Student-teachers were used not to answer the questions, but to facilitate discussion where the students shared their own answers. A total of ten small group sessions were held.

*Podcast review session*

For the 2007-2008 academic year, the TAs developed new, concise (15 to 25 minute) review sessions covering key concepts and example cases. Reviews were recorded as digital audio (podcasts) and distributed in coordination with topics covered in lectures and small group sessions. Podcasts were released twice weekly and were available to students throughout the course. Podcasts were recorded using a free-for-download program (Audacity™) in Wave Audio Format (.wav), and were encoded in MPEG-1, Audio Layer 3 (.mp3) at 128kbps. They were then distributed internally using both the course website and the Mayo Clinic intranet.

*Clinical problem solving sessions*

In the 2007-2008 academic year, a clinical problem-solving journal club was developed by the TAs and held three times throughout the course. Students were divided into groups of ten and were asked to work through cases from the *New England Journal of Medicine* "Clinical Problem-Solving" section[13-15]. Sessions were led by TAs who encouraged students to interpret clinical data with a focus on clinical decision-making. The major emphasis of these sessions included formulating a differential diagnosis and choosing diagnostic tests. At the conclusion of each case, there was a five-minute discussion of relevant pathologic findings.

*Student case presentation*

Students were divided into groups of 3-4 and given a pathologic case to solve, including a brief history of present illness and several pathology slides. Each group prepared a presentation on their assigned clinical case and delivered this presentation to their classmates. Case presentation sessions were conducted by the course director. These case presentations were unchanged from previous years.

*Evaluation of teaching modalities*

Upon completion of the 2007-2008 course, all students were invited to complete a brief, anonymous questionnaire regarding their perceptions of the course. This non-validated questionnaire was designed by the student-teachers as a device to evaluate their contributions to the course. The questionnaire asked students to rank their level of agreement with various statements on semantic differential scales from 1 to 10, with 10 being complete agreement. Students were questioned in this manner on their preferred learning style (Visual, Auditory, and Kinesthetic), as well as on the use of lectures, small group sessions, podcasts, clinical problem solving sessions, and student case presentations. Students were also asked to rank the five course components from in order of usefulness. While the study was not recruited to a power to show a specific level of correlation, correlation calculations between data points was performed using the Fisher's Exact Test. A cut-off value of 7 or greater on scales of 0 to 10 was used to distinguish between responses that were "strongly in agreement" and those that were not for Fischer's Exact Test. A p value of 0.05 was considered statistically significant.

## RESULTS

General summary data for our pathology course is outlined in Table 1. Forty-one (41) of 42 students completed the survey. Lectures were viewed as the most important component of the course, followed by the three student led initiatives, with student case presentations ranking as least important. Seventy-three percent (73%) of students preferred lectures less than two hours in length. Most students rated a visual learning style as their preferred format, although a non-trivial minority selected both auditory and kinesthetic.

*Students as teachers*

The small groups, podcast reviews, and journal clubs were all led by third year TAs. Students were very comfortable with student-teachers conducting these sessions (mean score 9.0/10). At the end of the course, students reported a very strong interest in teaching (8.4/10). Additionally, students reported a greatly increased interest in teaching as a result of the student-led pathology course (mean 8.0/10) (Table 1). Those who ranked TA led small groups highly were also significantly more likely to have increased interest in teaching at the end of the course (p=0.01).

*Small groups*

Senior medical student-led small groups ranked as the second most important component of the course. Sixty-eight percent (68%) of students attended all of the small group sessions, while 85% of students attended at least seven of the ten sessions. Eighty-three percent (83%) of students preferred small group sessions shorter than three hours. Visual learners found these small group sessions more helpful than non-visual learners (p=0.04) (Table 2). Auditory learners also tended to find these sessions helpful, although this did not reach statistical significance (p=0.19).

students (63%) made use of the podcast reviews. Students preferred a brief length, with 64% preferring less than 25 minutes per podcast and 93% preferring less than 45

| Table 1. General Statistics (n=41) | | |
|---|---|---|
| **Characteristic** | **Mean** | **SD** |
| Rank of course components | | |
| Lectures | 1.6 | 1.0 |
| Student case presentations | 3.6 | 1.0 |
| Small groups | 2.0 | 1.0 |
| Podcasts | 3.0 | 1.3 |
| Journal clubs | 3.6 | 1.4 |
| Learning style | | |
| Visual | 8.6 | 1.9 |
| Auditory | 6.0 | 2.7 |
| Kinesthetic | 6.1 | 2.7 |
| Learning style (highest ranked) | *(number ranking highest)* | |
| Visual | 34 | |
| Auditory | 11 | |
| Kinesthetic | 13 | |
| Teaching Interest | | |
| Interest in teaching | 8.4 | 1.7 |
| Increased | 8.0 | 1.9 |
| Medical Student Led | | |
| Comfort | 9.0 | 1.8 |

**Table 1.** General Statistics – Rank of course component: 1 (most favorite) to 5 (least favorite); Learning style: 1 (least preferred) to 10 (most preferred); Teaching interest: 1 (not at all interested) to 10 (most interested); Comfort with medical students as TAs: 1 (not at all comfortable) to 10 (most comfortable). Students were allowed to rank multiple learning styles of equal preference.

| Table 2. Correlation between course component preference and learning styles (n=41) | | | | | |
|---|---|---|---|---|---|
| | **Lecture** | **Cases** | **Small Group** | **Podcast** | **Journal Club** |
| **Visual** | 1.00 | 0.43 | **0.04** | 1.00 | 1.00 |
| **Auditory** | 0.13 | 0.52 | 0.19 | 0.68 | 0.27 |
| **Kinesthetic** | 0.69 | 0.20 | 0.73 | **0.01** | 0.45 |

**Table 2.** Correlations between course component preference and learning styles – all values are p-values from Fischer's Exact Tests. Learning preference data was reported on semantic scale from 0 (least preferred) to 10 (most preferred), with a score of 7 or higher indicating a strong preference. Course component preference data was reported on a semantic scale from 1 (most useful) to 5 (least useful), with a score of 2 or less indicating a strong usefulness.

Students were generally very comfortable with computers (mean 9.1 / 10, Table 3). A large majority of students (85%) own an iPod or comparable music player, and a majority of

minutes. Kinesthetic learners tended to find these reviews more helpful than non-kinesthetic learners (p=0.01).

| Table 3. Individual Components (n=41) | | |
|---|---|---|
| **Characteristic** | **Mean** | **SD** |
| Lectures | | |
| Helpful | 8.9 | 1.8 |
| Enjoyable | 8.6 | 1.6 |
| Student case presentations | | |
| Helpful | 6.6 | 2.8 |
| Enjoyable | 6.3 | 2.7 |
| Small groups | | |
| Helpful | 8.0 | 2.2 |
| Enjoyable | 7.8 | 2.1 |
| Journal clubs | | |
| Helpful | 5.9 | 2.6 |
| Enjoyable | 6.4 | 3.0 |
| Podcasts | | |
| Helpful | 6.8 | 2.3 |
| Enjoyable | 6.7 | 2.6 |
| Comfort with computers | 9.1 | 1.3 |

**Table 3.** Individual Components – All questions were asked on a scale of 1 (strongly disagree) to 10 (strongly agree).

*Journal club*

Sixty-one percent of students attended all journal club sessions. Journal club was generally thought to be less valuable than the podcasts, with 44% rating it as the "least valuable" component of the course. A sizeable minority (24%) of students, however, reported it as one of the two most valuable aspects of the course. No correlation was found between learning style and usefulness of journal club. However, students who found it a very helpful part of class reported large improvements in differential diagnosis formulation ($p<0.01$), a greater desire to read medical journals ($p<0.01$), and more excitement for upcoming clinical experiences ($p<0.01$).

## DISCUSSION

The methods we use to teach medical science are evolving[1]. The changes that drive this evolution are typically implemented from the top down, whether from new studies from educational experts, an institution-wide policy change, or a professor changing the way he or she chooses to teach. Our study sought to both implement and evaluate changes from the bottom up, utilizing senior medical students as the key drivers to this end. To our knowledge, the use of senior students as teachers has been little explored[6], while their use in curricular changes has not been reported. We found both the changes themselves and the utilization of students as teachers and curriculum designers independently interesting.

*New course additions: a student led initiative*

The 2007-2008 Pathology course at our institution was successful in allowing student-teachers to create, implement, and evaluate educational innovations. By combining mentorship with autonomy for innovation, the course director was able to harness ideas and energy from senior medical students to implement changes more quickly than might have been possible otherwise. This also encouraged the student-teachers to evaluate their changes to assess what impact, if any, they had on their students.

Before discussing the results of our survey outlined above, we must note this survey was performed for use by the student-teachers to evaluate their changes and has not been validated elsewhere. We also used student preferences as our endpoint, as opposed to a hard endpoint such as test score. Similarly, our study population was defined by our class size (42), and hence was not powered to show specific levels of correlation; significant correlations were potentially missed. We must also note that these findings are potentially relevant only to our own medical school.

These facts not withstanding, there are a few conclusions that can be drawn. While many medical school curricula –

including our own – are moving away from the all-day lecture format, lecture still rated as the most important aspect of our course. We attribute this to the ever expanding extent of medical knowledge leading to a need for direction towards important concepts and away from triviality. However, the length of time spent in lectures should be kept concise. In fact, 'short and sweet' seems to be an excellent motto for all components to the course, including lectures, small groups, journal club, and podcasts.

It is well established, and in fact common sense, that different learners prefer different learning styles[7] and different learning tools. In an independent learning curriculum where students are asked to self-teach, it is important to make a wide range of tools available. These should contain traditional tools, such as lectures and textbooks, but should also encompass alternatives. Today's students are exceedingly comfortable with technology; perhaps even more so than their instructors. Thus technologically advanced tools such as virtual histology and podcasts should be available. Similarly, with the pace of advancements in medical sciences, it is important to begin reading primary literature early in medical education. We demonstrated a course design with these multiple elements geared towards different styles of learners. Virtual histology-based small group sessions were significantly favored by visual learners, while brief podcast reviews were favored by kinesthetic learners. Correlations between auditory learners and preference for lectures and between kinesthetic learners and case presentations were present, although they did not reach statistical significance. This is potentially due to a lack of power in this study. Further work, potentially using test scores instead of student preference as the endpoint, are needed to elucidate these potential correlations.

These multiple learning tools do come with an important caveat. With the proliferation of educational materials and the increased role of self-directed learning, there is the potential for students to try to do too much. It is important for students to choose the tools that work best for them to learn the material, and not try to use everything available. Despite this potential pitfall, however, multiple learning tools in the classroom appear to be of benefit in a self-directed curriculum.

*Medical students as teachers and course designers*

A key aspect of our course changes was that medical students became teachers and drivers of course improvements.

Physicians occupy the dual role of learner and teacher throughout their careers. The field of medicine requires physicians to be lifelong learners, and physicians are in turn responsible for teaching patients, families, and colleagues. It seems appropriate to begin cultivating teaching skills early in a physician's career, beginning in medical school.
Our study demonstrates that first year medical students were comfortable learning from peers in the introductory pathology course, and that as a result of this course students had an increased interest in teaching. We believe that first year students, senior students, and future patients of these students may all potentially benefit from this type of course structure in which students are given the opportunity to develop teaching skills and take responsibility for improving the existing structure through curriculum reform.

First year students gain early insight into opportunities for teaching in medicine and may develop personal interest in teaching. They also gain early exposure to peer teachers and students who are taking action to improve courses. This helps to create a culture of continuous quality improvement and peer-teaching. As first year students advance through their medical education, it will become their responsibility to add or improve upon course components for future students.

Senior students gain invaluable experience as teachers. In addition to developing teaching skills, students also gain experience in leadership and innovation through taking responsibility for conscious re-evaluation and improvement of existing courses. Even patients may benefit from a cadre of physicians who have had an early opportunity to develop teaching skills and consciously evaluate and improve existing structures.

The changes that medical students were able to effect in this introductory pathology course would not be possible without an institutional culture conducive to student-teachers and student-driven reform. Our medical school has a long history of utilizing medical students as teaching assistants[16]. By involving students who recently completed the same courses, our teaching staff gains perspective on which aspects of their courses were effective and useful for students and which need modification. Student-driven curricular reform, as exemplified in this introductory pathology course, allows a curriculum to quickly adapt to changing needs and preferences of students, provides valuable teaching experience to student-teachers, and encourages conscious and continuous curricular improvement that benefits future students.

Further scientific analysis is needed to assess the utility of both this multifaceted approach to teaching pathology, as well as the utility of senior student led small groups and student-led initiatives. However, our data indicate that students appreciate a variety of different learning tools and that student-teachers and student-led initiatives cultivate teaching interest in first year medical students. This approach to medical education may foster a culture of peer teaching and leadership that would benefit medical students, their peers, and potentially their patients.

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# Impact of Podcasting on First-Year Medical Student Note-Writing Skills

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**ABSTRACT**

This project assessed the effectiveness of podcasting, a new tool for content delivery in medical education, to improve first-year students' note-writing and patient documentation skills and knowledge. Previous Objective Structured Clinical Examinations (OSCEs) revealed that many first-year students had poor note-writing skills. Therefore, a new series of six podcast episodes that taught note-writing skills, titled "SOAP Note 101," was developed and made available on the iTunes Music Store and the institutional website. Phase I involved three groups of students, those using institutional iPods, those using their own iPods, and those without any specific commitment to access the podcasts. Subject note writing skills during a non-graded portion of an OSCE were compared for each group. Phase II used a dose-response model to assess the degree of improvement in note writing on a graded OSCE and a cognitive exam, based on the number of podcasts to which students listened. Students favorably evaluated the podcasts and their availability as supplemental content. Note-writing skills and quiz scores increased slightly as the number of podcasts that students listened to also increased. Podcasting is well-liked by medical students, and they appreciate having access to asynchronous supplemental materials. Further research is needed to evaluate ways to increase effectiveness of podcasting in medical education.

## INTRODUCTION

As if shrinking financial resources, expanding medical knowledge, and demands for accountability weren't challenging enough for medical educators, they also face a new cohort of medical students filling their classrooms: "Millennial Generation" students accustomed to multi-tasking and to using technology to choose their own schedules for learning. This new generation of medical students, accustomed to defining their personal space with text messages, videos, music, and web access, will require medical educators to look to new and creative delivery modes—such as podcasting—to offer curricular content.

Almost any audio or video recording that has been saved in a digital format can become a podcast, and thus accessible by computer or available for downloading and transferred to an MP3 player such as an Apple iPod. Podcasts typically use RSS feeds, an acronym for "RDF Site Summary," but more commonly for "really simple syndication." RSS feeds allow the publication of frequently updated content such as podcasts, which can then be "pushed" to the user's own computer.

A podcast is a natural teaching tool, particularly for Millennial Generation students who already own and use MP3 players and multimedia smartphones, and they listen to music and other audio files on their computers and other devices. Podcasting is becoming more common in educational settings, most often simply to re-broadcast a previous lecture. Apple Inc., which clearly recognizes the educational opportunities inherent in podcasting, has partnered with several universities to form iTunes U, a hosted service for colleges and universities that provides student and faculty access to the institution's audio or video lectures or interviews.

The use of Podcasting in medical education has increased rapidly, with at least ten schools advertising that they use podcasts for teaching content.[1-6] Curricula being taught via podcasts include lecture content as well as demonstration and teaching in surgical procedures.[7] In addition, medical societies are utilizing podcasting to teach specialty subjects. Saveland and coworkers [8] describe the first successful design and implementation of a podcast by a national medical society by the Society of Critical Care Medicine.

The most common use of podcasting in medical schools has been to publish previously given lectures. Boynton *et al.*[9] demonstrated that students reviewing a video podcast of a lecture preferred this method and they performed better on written examination of the lecture material.

Some schools have started producing podcast episodes as independent supplemental materials, primarily because they allow students to access information on their own timetable. Some research has assessed podcasting as a curriculum tool outside of medical education, but there is little research confirming that this modality is an effective means of learning for medical students.

The purpose of this project was to research the effectiveness of podcasting in presenting supplemental material to first-year medical students. Previous Objective Structured Clinical Examinations (OSCEs) revealed some struggle in note writing by first-year students. We chose to produce a series of podcasts that taught note-writing skills and to assess the improvement in those skills using OSCEs.

## METHODS

The institutional review board approved the following research design. We developed a series of six podcast episodes, each lasting about 15-20 minutes, that address issues related to documentation and writing effective clinical notes. This series, titled "SOAP Note 101," was designed to supplement the instruction on note writing that first-year students received from faculty mentors in assigned clinics during the Early Clinical Experience (ECE) longitudinal block at Texas Tech University Health Science Center (TTUHSC). One episode was published onto Apple's iTunes Music Store in each of six weeks from October 30 through December 12, 2006, and they were also posted on TTUHSC website to be available free of charge. These episodes are exclusively audio to ensure their portability, simplify the preparation process, and minimize the file size. Each episode, as listed in Table 1, uses multiple voices and a simulated patient interview followed by commentary on effective documentation of that visit to address the subjective, objective, assessment and plan sections of the patient note.[11]

For Phase I of the study, conducted during the fall semester of 2006, we recruited 39 students into three self-selected study groups: 13 in Group A, who used TTUHSC-supplied iPods, 14 in Group B, who used their own iPods, and 12 in Group C, who did not commit to accessing the podcasts, but were not prohibited from doing so. Due to the number of TTUHSC-owned iPods, Group A was restricted to the first 14 volunteers, and the size of Group B was held at a consistent number. Although the number of students in Group C was comparable, we did not intend to limit the number of volunteers wishing to be a part of that cohort. No efforts were made to assess student learning styles. Students in both Groups A and B were educated about how to access the podcasts from the iTunes Music Store and transfer files to the iPod. Also during the fall semester, all first-year students were reminded about the availability of the podcasts and told how to find them on iTunes or the TTUHSC website.

Table 1. Texas Tech Medcast SOAP Note 101 Series Episodes[11]

| Episode Title | Recording Length (minutes) |
|---|---|
| SOAP Note 1 *Overview of the Medical Note* | 11:30 |
| SOAP Note 2 *Subjective: Chief Complaint and History of Present Illness* | 15:19 |
| SOAP Note 3 *Subjective: Documenting Chronic Illness* | 13:42 |
| SOAP Note 4 *Subjective: Summary* | 16:24 |
| SOAP Note 5 *Objective* | 15:39 |
| SOAP Note 6 *Assessment and Plan* | 19:06 |

In January of 2007 (approximately mid-point of the ECE block), all first-year students were required to participate in a 1-station OSCE experience, which included writing a patient note. The student note writing skills were evaluated from the "Student Note" portion of the OSCE by two physician educators outside of Texas Tech who were blinded to whether the students belonged to one of the three groups. The evaluators used a rubric designed by the course director of the ECE. Significantly, the "Student Note" portion of this OSCE was not used for any graded or summative evaluation of the medical students for the course.

Study participants were asked to fill out a project survey, which included evaluation of their use of podcasts, level of enjoyment of podcasts as educational tools, and retention of concepts taught in the podcasts. Content retention was measured via ten true-false or multiple-choice questions drawn from the published audio content of the podcasts.

For Phase II of the study, conducted in the Spring 2007 semester, we used a dose-response model to assess student outcomes based on the number of podcast episodes to which students listened, recruiting subjects from the same class of first-year students who participated in Phase I of the study. We encouraged all students in the ECE course to enroll in Phase II of the study, and we provided an iPod to any participant needing one; 88 students enrolled in this study phase. Students were encouraged to listen to as many of the podcasts as they wished and accurately report how many they listened to in the project survey. A summative OSCE with a graded "Student Note" was given at the end of the course year in May 2007. The course director graded the clinical note using the same rubric used in Phase 1. All participants were asked to fill out a project survey which included all of the earlier evaluated components (described above).

## RESULTS

Of the 39 students who signed consent forms for study Phase I, 21 participants (53.8%) completed the first evaluation instrument, 13 from Group A (TTUHSC iPods), 4 from Group B (personal iPods) and 4 from Group C (control or no commitment). Phase I results indicated that students used the computer as well as iPods to listen to the episodes, especially if they were members of Groups A or B. Students using TTUHSC-supplied iPods especially took advantage of the units, choosing that listening mode 85% of the time. Of the students in Group C, however, none used an iPod to listen to the podcasts. Nine respondents reported listening to all of the sessions, and 14 reported listening to the episodes as a review prior to the OSCE.

Respondents to the survey generally enjoyed the podcasts and appreciated having access to them. A 5-point Likert scale (5=Strongly Agree) designed to assess agreement with several statements describing podcasting in medical education revealed that students agreed most strongly that the podcast episodes were convenient to access (mean=4.0), were helpful in writing an effective OSCE note (mean=4.06), are a valuable teaching tool for medical students (mean=4.33), and are easy to understand (mean=4.44). Students agreed less strongly that they had adequate opportunities to listen to the podcasts (mean=3.67) or that they would seek out podcasts related to their medical education, aside from this project (mean=3.61).

The evaluation of the "Student Note" portion of the OSCE showed that all study groups received essentially the same scores for completeness and quality of their clinical note by the external reviewers. Average scores for each were Group A with 75.6%, group B with 72.3% and group C with 77.3%; these differences were not statistically significant.

All of the 88 students who enrolled in Phase II responded to the second evaluation instrument, including 34 who had been enrolled in Phase I of the study. In this phase only 20 of the participants reported to listening to the podcasts on an iPod or MP3 player, and when asked to rank their preferred listening method, 54% chose a computer over an iPod or other portable listening device. About one-third of the respondents reported listening to the SOAP Note podcasts as a review before their spring OSCE, and all of those students listened to the episodes "all at once."

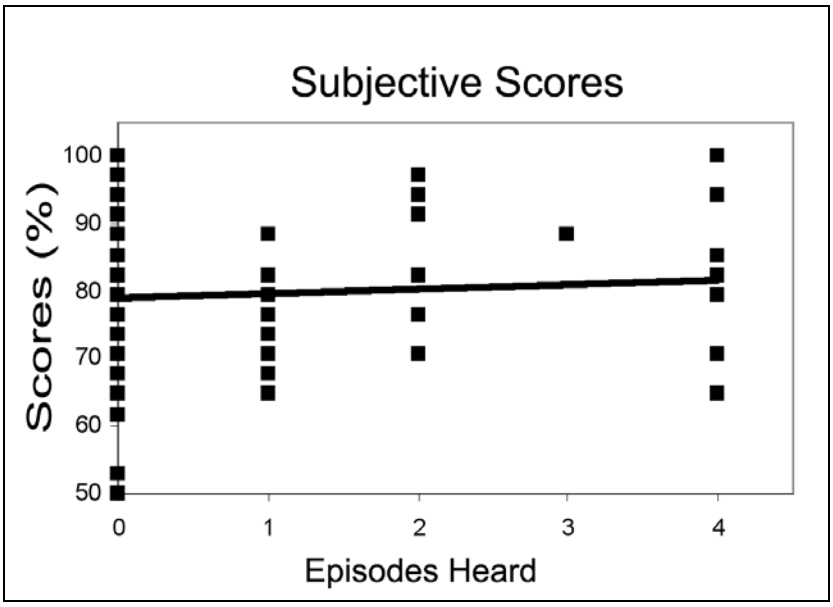
On the 5-point Likert scale (5=Strongly Agree) that assessed student opinions about podcasting in medical education, respondents again showed satisfaction with podcasting, but at somewhat lower levels than in the previous survey. Significantly, they still agreed that the podcast episodes are a valuable teaching tool for medical students (mean=4.18), and are easy to understand (mean=4.18). However, a new statement, added to test our hypothesis that use of the podcasts would be higher if the OSCE patient note were graded, garnered the lowest agreement (mean=3.2).

Linear regression analysis of the "Student Note" portion of the OSCE showed that for each podcast listened to, the score of the written note increased by 0.9 percentage points (Figure 1). This result correlated with the participant scores on the 10-item cognitive quiz, which showed an increase of 0.5 percentage point for each heard podcast. The correlations between score and podcast sessions heard were weak ($r^2 < 0.8$ for both) but positive for both the "Student Note" and the cognitive quiz.

## DISCUSSION

The finding that students use their computers rather than the iPods for listening to the podcasts, as well as that students are generally pleased with this form of pedagogy, is consistent with results from educational studies on podcasting in education outside of medicine.[10] Phase II of the project was designed after the results of the initial project were analyzed. We felt that one possible reason that the participants in all study groups had done equally well in the clinical note writing during Phase I of the study was because the "Student Note" portion of the OSCE was formative and ungraded. A summative or graded "Student Note" portion of the OSCE probably did prompt more students to take advantage of the podcasts, although only 32% of participants

Figure 1. Correlation of the Student Note Score to the number of podcast episodes to which subjects reported listening. The four episodes that directly related to the scoring of the clinical note were included in this analysis.




reported listening to the episodes specifically as a review prior to the OSCE. Though the increase was small, our dose-response model did reveal that as students listened to more podcasts, their OSCE student note grade improved and their cognitive learning scores increased.

In a whitepaper on podcasting in education, Deal suggests podcasting "is only valuable inasmuch as it helps the instructor and students reach their educational goals," and thus is a function of the educational context in which it is used.[10] We concur with those conclusions, and we further argue that the value of podcasts is very much in the eye of the individual student beholder. Those students who want more control over their time and learning environment like podcasts the most and are more likely to use them. Anecdotal responses and narrative comments suggest that learning styles may be related to satisfaction levels; students who are auditory learners seem to like podcasts better than do those students who are visual or tactile learners.

We further recognize that podcasts represent a passive learning form, where medical students listen to the delivered content. Passive learning, whether delivered digitally or live, remains instructor-driven, rather than learner-driven[12]; as such, podcasts are but one of many means to engage medical students in acquiring and applying knowledge.

Our finding that students are generally pleased with this form of information delivery is likely due to two reasons. First, it allows them control over the time and location to review the materials. The finding that most students listen to podcasts at their own computer shows a conscious decision to listen to the material in the most convenient way. Second, this form of information delivery resonates clearly for a generation of learners who are comfortable with a digital, controllable delivery and with giving continuous partial attention to surrounding stimuli.

Although the six episodes for SOAP Note 101 were prepared specifically for first-year medical students and although both phases of the study have long since been completed, we continue to receive requests for information about these episodes from faculty at our institution and elsewhere and at all levels, including clinical clerkships and residency programs. Statistics from the Texas Tech iTunesU site, which was not in operation during this study period, continues to show more than 10 downloads per week for SOAP Note episodes, suggesting that the content they cover is useful and the format is convenient.

## CONCLUSIONS

We caution against the use of podcasting in medical education as a replacement for traditional lectures. Rather, we suggest that podcasts are most valuable to provide teaching content that is supplemental to ongoing curricula and to give students more control over access to their learning environment. Even if students do not actively avail themselves of podcasts, they appreciate their availability and the *option* of using them. An additional challenge will be finding ways to utilize this medium in a manner that also increases student retention of the material. Encouraging

students to produce their own podcasts as an educational exercise, for example, may place them in a more active learning role with potential to increase learning, a project that is currently underway with fourth-year students at our school.[13]

Additional studies on podcasting should assess the added value of student-produced episodes as well as the relationship between learning styles and success or satisfaction with podcasting in medical education.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# Student Utilization of Digital Versions of Classroom Lectures

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**ABSTRACT**

Video screen capture recordings with audio of live medical school lectures, with variable speed playback options, have been available for most basic science courses in the preclinical curriculum for 2 years, including courses in Year 1 (discipline-based curriculum primarily delivered by classroom lectures) and Year 2 (modified problem-based learning curriculum with up to 7 lectures per week). The purpose of this study was (1) to assess student perspectives on the extent and pattern of use of the digital materials, features important to students, and the perceived impact on student performance, and (2) to determine if there were differences among students in the use of the online lectures in Year 1 courses (discipline-based lecture-based curriculum) and Year 2 courses (modified problem-based learning curriculum). Survey results of four student cohorts indicated that students in both curricular types perceived that online lecture recordings were an important component for studying basic science content. With respect to type of use, 77% of Year 1 students and 53% of Year 2 students used the online lecture files in addition to attending live lectures. A greater percentage of Year 2 students indicated they watched the online lectures instead of attending class. Student views on effectiveness varied: the majority (84% of all students responding) indicated that online lectures are just as effective as or more effective than live class lectures; the remainder said they are less effective. Most students (over 80%) used the variable speed playback option. Over 75% of students indicated a positive subjective effect on study habits and exam scores ("learning the material better"). Further analysis of the value of specific features and the patterns of use of the video files will assist with strategic planning for using technology to support instruction and to improve student learning.

## INTRODUCTION

In the last several years there has been an increased use of digitized lectures in medical education, involving audio/screen capture and/or videorecording of lecturer, made available in a web-based format to medical students after delivery of lectures. The positive impact of lecture recordings in individual courses has been reported.[1, 2] Student response to recordings in a Molecular Foundations of Medicine course was universally positive and students felt that the availability of lecture recordings aided their studies and reduced stress and anxiety.[2] However, there have been few studies investigating how the digital recordings are used, subjective effectiveness, or important technical features for lecture recordings across a curriculum. At Michigan State University (MSU), audio recordings of all preclinical medical school lectures have been available to medical students for over 15 years. Beginning in fall 2005, we started recording screen video as well as audio during classroom lectures for some Year 1 basic science courses. The live lectures were recorded digitally using screen and audio recorder software capable of real time content playback, and digital recordings were available through the Internet the day following the lecture. Beginning in spring

2006, asynchronous web-based access to classroom lectures was provided for some Year 2 courses. Beginning in fall 2006, web-based asynchronous access to classroom lectures in both Year 1 and Year 2 courses was routine, because of the positive response by students.

This study was designed to assess student perspectives on the extent and pattern of use of the digital materials, features important to students, and subjective educational benefits. We hypothesized that there would be differences among students in the use of the online lectures in Year 1 courses (discipline-based lecture-based curriculum) and Year 2 courses (modified problem-based learning (PBL) curriculum with more independent study and fewer lectures than in Year 1 courses).

## METHODS

### *Lecture recording methods.*

Camtasia Studio (TechSmith, Okemos, MI, http://www.techsmith.com), a low-cost program that records audio and screen content, was used to record classroom lectures. Presentations included one or more of the following digital elements: PowerPoint files, text documents in Windows Journal on a Tablet PC, demonstrations from websites during the lecture, and integration of external video and audio files that enhanced the lecture content. Instructor annotations during the lecture, such as screen arrows, circles, and written text, were recorded in real time. When PowerPoint was used, the title of each PowerPoint slide was automatically inserted into a Table of Contents by the Camtasia Studio software; during playback students could then click on a slide to jump to that point in the presentation. If PowerPoint was not used, the instructor inserted markers/titles after the lecture to generate an online Table of Contents. Technology staff rendered and compressed each file, and prepared it for streaming and for download. The links were usually available within 24 hours after the lecture. Students could adjust the playback speed of the lecture using Windows Media Player.

### *Student surveys.*

Voluntary anonymous surveys (approved by the MSU IRB) were conducted including questions (both Likert scale and open-ended) about the frequency of use of online lectures during the semester, their perceived effectiveness, and the technology used to access such lectures. The surveys involved three cohorts of students (entering classes of 2004, 2005, 2006) surveyed at selected time points to capture feedback after different degrees of experience with online lecture availability as summarized below. The first two surveys were conducted after students had access to online lectures for part of a semester, and not in all courses. We considered that this was not sufficient exposure to be reliable for statistical analysis, but was useful for comparison with the later surveys. The last two surveys were conducted at the end of fall semester 2006, after most lectures in all basic science courses were recorded for a semester.

- Fall 2005 mid-semester - Year 1 students (entering class of 2005; N=106; fall semester lectures recorded for first time in two of the three basic science courses)
- Spring 2006 mid-semester - Year 2 students (entering class of 2004; N=106; pilot use of recordings in Neuromusculoskeletal PBL course; students did not have video recordings for Year 1 courses)
- Fall 2006 end of semester - Year 1 students (entering class of 2006; N=106; most fall semester lectures recorded)
- Fall 2006 end of semester - Year 2 students (entering class of 2005; N=106; most fall semester lectures recorded)

### *Analysis of comments.*

There was analysis (by Dr. Lovell) of written comments, to extract and categorize the comments related to general use of online lectures, type of use in relation to class attendance, type of use in relation to understanding the content, comparison of live and recorded lectures, and technical features of the online lecture system (eg, speed of playback, streaming vs download options).

### *Statistics.*

A chi-square test was used to compare survey results between Year 1 and Year 2 students for the survey data collected at the end of fall semester 2006 (Year 1 students matriculating in 2006; Year 2 students matriculating in 2005). The null hypothesis was that there was no difference between the two groups. The null hypothesis was rejected if $p < 0.05$.

## RESULTS

The percentages of student responses for each cohort for most questions are indicated in Table 1. With respect to number of lectures replayed, more students used the lecture recordings in the fall 2006 surveys (over 95%) than in the earlier surveys in semesters when lecture recordings were initiated (80-90%). There was no significant difference (chi-square = 2.85; $p = 0.24$) in the pattern between the Year 1 and Year 2 students in the fall 2006 surveys.

With respect to the type of use (why/how do you use online lectures?), there was variation among students. Responses in Table 1 show that a greater number of Year 1 students, compared to Year 2 students, used the lecture recordings to selectively review difficult concepts after attending lecture (chi-square = 10.86; $p = 0.001$ for the fall 2006 survey data). For this survey question, students could check all responses that were appropriate, and the percentages in Table 1 reflect students that selected that option as one of their responses. Analysis of subcategories of responses (different combinations of the three options) provided additional information about lecture attendance. For example, a student who checked ONLY 'watch after missing lecture', but not

Table 1. Responses to survey items by each cohort

| Matriculating year<br>Student status<br>Semester survey conducted | 2005<br>Year 1<br>Fall2005 | 2004<br>Year 2<br>Spr 2006 | 2006<br>Year 1*<br>Fall2006 | 2005<br>Year 2*<br>Fall2006 | Total<br>overall |
|---|---|---|---|---|---|
| Response rate | N=92<br>(87%) | N=97<br>(91%) | N=102<br>(96%) | N=60<br>(57%) | N=351<br>(83%) |
| **How many lectures replayed?** | | | | | |
| most | 19% | 45% | 46% | 54% | 41% |
| some | 32% | 25% | 43% | 30% | 32% |
| a few | 31% | 16% | 9% | 13% | 17% |
| none | 18% | 14% | 3% | 3% | 9% |
| **Why/how do you use online lectures (check ALL that apply)** | | | | | |
| review difficult concepts after lecture | 57% | 40% | 73% | 47% | 54% |
| listen to most of the lecture again | 30% | 18% | 28% | 28% | 26% |
| watch after missing lecture | 58% | 73% | 63% | 76% | 67% |
| **How effective are online lectures in conveying course content?** | | | | | |
| more effective | 27% | 36% | 25% | 47% | 34% |
| just as effective | 58% | 50% | 57% | 37% | 50% |
| less effective | 15% | 14% | 18% | 16% | 16% |
| **Variable playback speed responses** | | | | | |
| used variable playback speed | 72% | 83% | 96% | 86% | 84% |
| rated useful (4 or 5 on 5-point scale) | N/A | 96% | 97% | 100% | 98% |

*End of semester data used for statistical comparison of Year 1 and Year 2 students
N/A: no data available

either of the other options (data not listed in Table 1) was assumed to use the online lectures instead of attending class most of the time. For the fall 2006 surveys, the percentage of Year 1 students who selected ONLY 'watch after missing lecture' was 18%; for Year 2 students the percentage was 38%. The difference between Year 1 and Year 2 students

was significant (chi-square = 8.81; p = 0.003). This suggests that a greater percentage of Year 1 students attended lectures in fall semester; however, the Year 2 students who returned the survey may be biased toward that population who relied more heavily on the digital recordings.

Most students indicated that online lectures were more effective (34% overall) or just as effective (50% overall) than live class lectures, but 14-18% consistently said online lectures were less effective, and many comments indicated that live lectures were extremely important. A significantly greater percentage of Year 2 students perceived that online recordings were more effective (for the fall 2006 surveys, the difference in pattern of the three responses between Year 1 students and Year 2 students was significant, chi-square = 8.84; p = 0.012). Elements that may have contributed to this difference include more variation among Year 2 lectures in the extent of handouts or coursepack material, more lecture style variation among multiple lecturers, and the lower response rate with possible bias in the population responding.

Most students (over 80% overall) used the variable speed playback option, and thought it was very important (Table 1). With respect to the options of streaming video or downloading the lecture files (information obtained through comments), students were variable in their preference, but said it was very useful to have the download option if they were going to be away from internet access or have a connection that was not always reliable for high-speed access.

In the fall 2006 surveys, students were asked about the subjective effects of the "availability of online lectures on exam scores (learning the material better)." For Year 1 students, 88% indicated a subjective positive effect on exam scores, 12% indicated no effect, and 0% indicated a negative effect. For Year 2 students, 75% indicated a subjective positive effect on exam scores, 24% indicated no effect, and 1% indicated a negative effect. There was no significant difference between the two groups (chi-square = 5.64; p = 0.059).

In addition to comments about wanting to have online lecture recordings available the same day as the lecture, representative comments about using online lectures are listed below.

How lectures are used:

- Being able to stop, rewind and playback the parts I want to review to ensure I have the concepts down is very helpful.
- I watch the videos if there is an exam soon and I miss lecture to study.
- I really enjoy the availability of these lectures; I can listen to the lectures at a time when I am ready to learn and at my convenience.
- Recordings are really useful for exam studying at fast playback speeds. I come to lecture intentionally; a recording is ideal for review and clarifications.

Major reasons why online lectures are more effective than live lectures:

- Ability to pause, rewind, replay sections that were not clear in lecture is important, and the feature of finding specific topics in the table of contents is very helpful.
- Recordings provide flexibility and convenience in time.
- Capture of instructor annotations, especially when diagrams or images were used, provides all content information needed.
- Listening to lectures online at fast speed is much more stimulating.

Reasons why online lectures are less effective than live lectures:

- You can't see the instructor's gestures.
- Live class lectures are more interactive and visually stimulating.
- I can't focus as much sitting in front of a computer.

Thus, students indicated that the effectiveness of online lecture recordings was related to key features of the recording and play-back capabilities, as well as having an online video of the content that was delivered.

## DISCUSSION

In a summary of research on a variety of Web-based learning options, Cook[3, 4] suggested that investigations related to Web-based learning materials should go beyond media-comparative research to determine elements of digital materials that are effective in specific education settings. Increasingly medical schools in the United States are providing students access to recorded classroom lectures, and there have been many discussions about the effectiveness of this approach on student learning and the effects on classroom attendance. A few published studies have looked at some of these issues for medical schools or other educational sites. For example, Pilarski and coworkers.[2] reported on the impact of lecture recordings in a Molecular Foundations of Medicine first-year course; students felt that the lecture recordings helped them learn course material and reduced stress and anxiety, with no apparent adverse effect on classroom attendance. Billings-Gagliardi & Mazor[5] concluded that access to electronic materials did not influence students' choices about lecture attendance. Several studies utilizing medical students in both preclinical and clinical years[6-9] or other educational settings[10] have compared test performance for students attending a live lecture versus students viewing a digital lecture or other digital materials. In general there is no significant difference in outcome (academic performance

measure) and the students thought the online materials were as effective as or more effective than the live lectures.

In our experience, preclinical medical students perceived that online lecture recordings available on-demand with variable speed playback were an important component for studying basic science content. Most students in both curricula (Years 1 and 2) rated the online lectures as an important part of their learning strategies, accommodating individual schedules, backgrounds and learning styles, and allowing them to tailor their experience to meet personal learning objectives. This has been also demonstrated by others[2, 9]. Important features listed by students included variable playback speed, ability to pause and replay sections, effective table of contents, access within 24 hours or less after the lecture, capture of instructor annotations, and availability of multiple delivery formats (eg, streaming, download, iPod and PDA). Variable playback speed was also reported to be important in other studies[11]. The availability of these features should be considered in selection of technology to record lectures.

In the fall 2006 surveys, there were significant differences between Year 1 and Year 2 students related to specific types of use and effectiveness of lecture recordings. These differences may be related to the year in medical school, the different types of curricula for Years 1 and 2 in the MSU College of Human Medicine, or bias which may have occurred in the lower response rate of Year 2 students. Further studies to clarify the issues contributing to the differences would be helpful in planning for optimal effectiveness of lecture recordings or other digital materials.

Several previous studies, which have investigated the impact of electronic course materials on lecture attendance[5, 12, 13], indicated that the decisions by students to attend lectures did not appear to be related directly to the availability of online materials. Although our study was not specifically designed to determine effects on lecture attendance, there was a higher percentage of Year 2 students (compared to Year 1 students) who reported watching recordings instead of attending lecture. However, there was no data to support a change in classroom attendance due specifically to the availability of lecture recordings, since the Year 2 students in a PBL curriculum have multiple approaches for learning the basic science content.

A weakness of this study is that we were not able to measure academic outcomes related to student use of online lecture files, or how much of the perceived "learning the material better" was actually realized on exams. However, a number of studies have investigated the effects of digital materials or televised lectures on student performance, and concluded that effectiveness of digital materials was similar to that of traditional methods[3, 4, 6-8]. Investigations of specific features or types of use of lecture recordings or other digital materials that contribute most effectively to student learning are warranted.

## CONCLUSIONS

Preclinical medical students perceived that online lecture recordings with variable speed playback and flexible navigation were an important component for studying basic science content. Most students used the online lecture files in addition to attending live lectures, in order to review and master concepts. There were significant differences between Year 1 and Year 2 students for several specific responses, suggesting that issues related to use of electronic materials should be considered for the audience involved. Further analysis of the value of specific features and the patterns of use of the digital recordings will assist with strategic planning for educational technology to improve student learning and retention.

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# Integrative Teaching: Problem Solving and Integration of Basic Science Concepts into Clinical Scenarios using Team-Based Learning

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## ABSTRACT

The first-year medical curriculum at The University of Texas Medical School at Houston (UTMSH) comprises traditional discipline-based basic science courses and an Introduction to Clinical Medicine (ICM) course in which students learn the rudiments of the patient interview and physical exam. Integration of material across diverse courses is a key aspect of modern, competency-based curricula, and can be difficult to achieve in a traditional, discipline-based curriculum. To accomplish a degree of integration, the first-year course directors developed Clinical Applications, a course that meshes information presented in the basic sciences with skills learned in the Introduction to Clinical Medicine course using a team-based learning approach.

Seven integrative problem-solving sessions were introduced into the first year curriculum, four in the first semester and three in the second. These sessions utilized clinical scenarios of patient problems, and integrated content from at least three first-year courses in each session. A concerted effort was made to incorporate concepts from first-semester courses into sessions in the second semester, thereby promoting vertical and horizontal integration. Clinical scenarios were diverse and included topics of infertility, premature birth, sickle cell anemia, HIV infection, diabetes mellitus, renal failure, cardiovascular disease, cancer, neuronal pathways and pain, and travel medicine.

Results from the inaugural year of this course suggested that clinical problem-solving exercises presented in a team-based learning format were effective for integrating basic science concepts in a traditional discipline-based curriculum. The course also facilitated communication among all the directors of first-year courses and encouraged more integration in the first-year curriculum.

## INTRODUCTION

In recent years, the majority of medical educators have come to accept that "there needs to be a better integration between clinical experiences and the basic science courses."[1] Although rote learning is useful and advantageous in certain learning situations,[2] it has become evident that simple regurgitation of facts does not make a good physician and implant medical competence into students.[1] There have been enormous changes in mechanisms of health care delivery and an explosion in technology, medical developments and medical research, resulting in students

facing massive amounts of new information to integrate and study. It was therefore inevitable that educational trends had to address not only what medical students learned, but how they learned.[3,4]

With the inevitable changes to curriculum, aims, scope and outcomes, and new teaching models, it is paramount that beneficial transformations are made to medical school teaching strategies. New strategies, such as those found at CanMEDS,[5,6] the University of Dundee Centre for Medical Education (http://www.dundee.ac.uk/meded/frames/home.html) and the teaching academy at the College of Physicians and Surgeons at Columbia University (http://www.education.cumc.columbia.edu/glenda_garvey/recipients.html), are becoming standard methodologies to facilitate teaching and facilitation is critical in light of the heavy burden on today's medical student, brought about by the increase in information available in an ever changing electronic world.

The overall objective of the UTMSH Medical School curriculum is that students acquire the knowledge, skills, behaviors and attitudes that will lead to their becoming competent and compassionate physicians. The list of core competencies states that graduating students will "understand and have knowledge of the scientific principles including genetic, molecular, and physiological mechanisms basic to the practice of clinical medicine, and be able to use these principles in providing health care of common diseases."[7] Cognizant of the academic culture of our medical school, we have had to re-evaluate what components were needed in our curriculum in order to produce not only the type of student physician that we, as instructors, wanted, but more importantly, the type of physician that patients would desire.[8] This type of student physician is a person who 1) communicates well, 2) can define a problem, 3) knows treatment options, 4) shows respect for the patient and others, 5) works well in a team, and 6) accepts constructive input and can self-reflect accordingly.[9]

One area that most faculty thought could be developed was the ability of first-year medical students to apply principles presented in their basic science courses (Biochemistry, Developmental Anatomy, Gross Anatomy, Histology, Immunology, Microbiology, Neuroscience, and Physiology) and skills learned in Introduction to Clinical Medicine (ICM) into formulating solutions of clinically related problems. In order to help them develop this competency, the first-year course directors strived for a method of teaching that was interactive, integrative, and enjoyable for the students; a course that drove the students to think individually and as a team, while giving them an understanding of the value of competency in the basic sciences. We chose team-based learning (TBL), which had been applied in a few of our first-year courses, as the teaching modality to best satisfy these requirements.

Team-based learning (TBL) is a tried and trusted teaching method that, when utilized properly, is a valued addition to the medical school curriculum.[10] TBL consists of three learning phases: 1) the preparation phase in which students prepare for the TBL sessions by completing assigned reading, 2) the readiness assurance process during which students take a short test on the assigned reading, first as an individual and then as a team, 3) and the application phase, in which the concepts the students have learned in the first two phases are applied to solving problems.[11] This strategy has the advantage that it can be utilized in classrooms with high student-to-facilitator ratios.[12,13] TBL has been introduced into many facets of medical and health science education, from the undergraduate stage[14] through the clerkship level,[15] since with this approach, active learning is fostered, and student attitudes and interactions are improved.[13] Indeed, a recently published book details how to use TBL advantageously in health professions education, again stressing the positives of active participation, better knowledge retention and the promotion of self-directed learning.[16] Essential to successful implementation is that all participants, from administrators to faculty, invest sufficient time and resources to develop TBL exercises to ensure desired, positive outcomes.[17]

In this report, we describe the construction and implementation of an integrative course at our institution entitled Clinical Applications. We used an innovative implementation of TBL as the teaching modality to help first-year medical students integrate principles learned in their basic science courses and skills learned in ICM, by applying these principles and skills to the solution of problems presented in clinical scenarios. Overall, Clinical Applications was well received by students,[18] but with a few surprising outcomes that may impact the future administration of the course. This is a course that we believe will strengthen students' skill sets as they journey towards becoming knowledgeable, competent physicians.[19]

## METHODS

Students were asked to complete team-based learning tasks within a 90-minute session; seven such Clinical Applications classes were held throughout the first year, with two distinct cases revolving around a central theme presented in each session. The first-year class was divided into 40 teams of six students, corresponding to their Gross Anatomy tank groups, thereby increasing both the continuity and cohesiveness of learning within each team. Students prepared for the integrative sessions by individually completing pre-assigned readings and reviews of targeted basic science lecture material. Mastery of this material was assessed by a readiness assurance quiz. Students first take the quiz individually (IRAT - Individual Readiness Assurance Test), and then retake the quiz as a team, arriving at an answer by team consensus (GRAT - Group Readiness Assurance Test).[20] User-friendly 'scratch off' answer sheets were employed for the GRAT to provide immediate feedback of success in answering the question (Immediate Feedback Assessment Technique [IF*AT], Epstein Educational Enterprises, Princeton Junction, NJ, USA). The groups were then given a clinical scenario that formed a

framework for a series of related problem sets to be solved through group discussions, followed by feedback from faculty presenters. Teams composed a one-page written justification of their answer to each designated problem within the set and submitted the justification for grading.

Following intra-group discussions, team presentations of answers were facilitated by the first-year course directors, a process best accomplished when all first-year course directors were present to reinforce horizontal and vertical integration. An example of a session worksheet, this one pertaining to the biochemistry/chemistry of diabetes, is shown in Figure 1.

As different aspects of the clinical scenario were explored, concepts relating to diverse first year course instruction were introduced. Figure 2 shows a question from the same diabetes case, illustrating how elements of histology, cell biology, biochemistry and immunology were combined to synergistically develop a diagnosis. In this question, students were shown immunohistochemical staining of pancreatic acinar cells and transmission electron microscopy of liver structures, and asked to identify the pair of images demonstrating corresponding changes associated with uncontrolled Type I diabetes.

Students were evaluated based on i) their individual performance on the IRATs; ii) on their team's performance on the GRATs and team written justifications, and iii) on their performance on a team-task based final exam (Table 1). Online evaluations by the students of the course content and structure were administered at the end of each semester.

Prior to implementing Clinical Applications as a stand-alone course, the course was piloted for three years beginning in 2004. The course was conducted under the administration of ICM, the only year-long course in the first-year curriculum at that time. During the first two years of this pilot stage, a modified version of team-based learning was introduced that used only the application phase of the process. In the last year of piloting the process, the complete TBL strategy was utilized, as described above. During the three-year pilot phase, clinical scenarios were presented in a sequential fashion to the whole class using PowerPoint® slide presentations with application exercises introduced at appropriate intervals.

Once Clinical Applications became a stand-alone course, the clinical cases and application exercises were distributed to the teams as a packet of printed materials. This encouraged the students to work at a faster pace, thereby helping the faculty complete the sessions in the allotted time. The final exam was given in a format similar to a Clinical Applications session in that clinical scenarios were presented and questions were asked about the problems presented within that case. Students were to synthesize their answers using the knowledge they had gained from their basic science and ICM courses. The answers to these questions were short answer or brief essays that were compiled by team consensus. The teams submitted their answers electronically using the Digital Dropbox on the course Blackboard® site within the allotted time. All team members received the same final exam score.

To measure their perceptions of the integrative sessions, students were given the opportunity to evaluate the course after each semester using the survey tool of Blackboard®. Survey content and items were generated to assess whether students thought the sessions helped them understand material presented in the ICM course and their basic science courses and whether the sessions helped them apply basic science concepts to clinical situations. Other items queried whether the students perceived themselves and their team members as being actively engaged in the sessions, their perceptions and conclusions as to the usefulness of the readiness assurance process, the effectiveness of using hardcopy printouts of the cases and problems, and the format of the final exam. Student responses for these items were on a five-point Likert scale. Students' opinions about the size of the teams and the number of TBL integrative sessions that should be presented over the course of the year were solicited. In addition, students were given the opportunity to submit written comments about 1) how they thought student participation could be increased, 2) the format of the final exam, and 3) how the course might be more effective.

A focus group of 11 students recruited by the student evaluation committee was convened and facilitated by the Office of Educational Programs after the first year of Clinical Applications as a stand-alone course. The purpose of the focus group was to gather additional input from students regarding strengths and weaknesses of the course, administration of the course, course improvement, and whether the course helped them apply basic science principles to clinical problems. All comments were recorded anonymously and compiled by the Office of Educational Programs before being forwarded to the faculty of Clinical Applications for their careful review.

## RESULTS

The number of students that participated in the course during the three pilot years and the first year as a stand-alone course, as well as the response rates on the online student evaluation surveys, are presented in Table 2. The increase in the number of participants is a result of a decision by UTMSH to increase the class size by 15%. Since the evaluations were voluntary and administered on-line, the response rates are variable. Increased response rates were obtained when students received several email reminders.

The feedback received from the online student surveys is presented in Table 3. The five-point Likert scale has been simplified to Positive, Neutral and Negative responses. The combined feedback for the first three years of the pilot course is compared with that for the first year of Clinical Applications as a stand-alone course. The total number of responses varied for each question because not all students responded to all of the items in the survey. As can be seen from Table 3, the feedback received during the first year of

Figure 1. Typical session worksheet for a case involving diabetes mellitus.

**Case 1:**

A 47-year-old Caucasian male, was brought by his family to the emergency room in a semi-comatose state. On the day of admission, his wife noted that after lunch he went to take a nap complaining of fatigue. Several hours later his wife found him in bed and had difficulty awakening him. Alarmed because she noticed a strange odor on his breath, she and her son transported him to the local hospital ER.

On examination, the patient was somnolent but could be reawakened and would respond to his name. He was observed to be slender and of normal proportions. His pulse was 112 (normal, 60-100), blood pressure 130/70 (normal, 120/80), respiration 28 and very deep (normal, 16-20), temperature 97.8 F. His skin turgor was poor and his eyes appeared sunken. A fruity odor on his breath was noted.

His family indicated that his general health had been good and that he was not on medication. They also related that a few weeks earlier he began to complain of excessive thirst, and that he had started to awaken at night and go to the bathroom with increasing frequency. He also had begun to lose weight despite a good appetite. He also complained of visual blurring, which he ascribed to his work on a large set of plans he was preparing in his job as a draftsman. On the day of admission, his wife noted that he had consumed a 2-L bottle of soft drink before noon.

1. A blood sample was taken and sent to the laboratory for analysis. Given what you have learned through the physical examination and the history obtained from the family, which of the following blood chemistries would you expect to see?

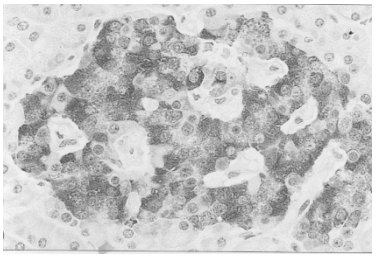
| | **Glucose, mg/dL** | **Urea Nitrogen (BUN), mg/dL** | **Serum ketones** |
|---|---|---|---|
| ***Normal Values*** | ***70 – 110*** | ***7 – 18*** | **none** |
| **A.** | **120** | **10** | **none** |
| **B.** | **65** | **35** | **moderate** |
| **C.** | **967** | **21** | **small** |
| **D.** | **629** | **30** | **large** |
| **E.** | **85** | **16** | **small** |

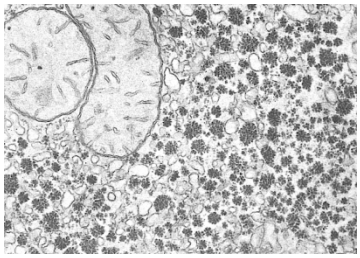
the stand-alone course is consistent with that obtained during the three pilot years, and our comments will focus on the stand-alone course, unless otherwise noted. A sizable majority of students (72.8%) responded that the Clinical Applications sessions help them to better apply their basic science knowledge to clinical manifestations of disease, and augment their understanding of how basic science concepts are useful in comprehending disease initiation, diagnosis and progression. Fewer students (49.0%) agreed that the sessions were useful in helping them understand the actual material presented in their basic science courses, and that the exercises helped them understand concepts in ICM (34.3%). The proportion of students who felt that the pre-reading assignments were useful in preparing for the exercises in the stand-alone course (44.4%) increased from that of the pilot years (22.3%). While most of the students responded that the GRAT was a useful learning activity (60.7%), the opposite was true with their views regarding IRAT exercises (23.0%).

A large majority of the students felt from the inception of the integrative TBL sessions during the pilot years that they and their team members were actively engaged during each of the exercises (85.5% and 74.7%, respectively). However, when the case scenarios and application exercises were distributed as printed paper handout packets (stand-alone course), instead of via projected PowerPoint® images (pilot years), students' perception of their own and their team members' active participation increased (94.6% and 82.1%, respectively). In addition, since beginning these TBL sessions 79.6% of the respondents (682) believed that the size of the team (5-7 members) is appropriate and 82.7%

Figure 2. Typical session worksheet for a case involving diabetes mellitus that integrates material from histology, cell biology, biochemistry and immunology.

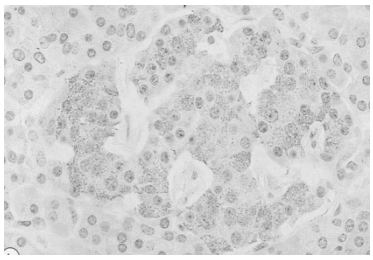
2. If you were to histologically examine tissue from liver and pancreas from this patient, which of the following pairs would you most likely observe?

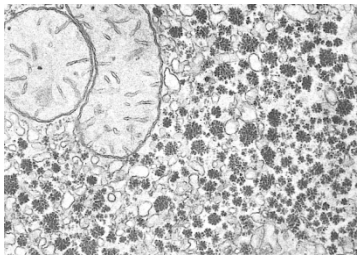




EM of liver

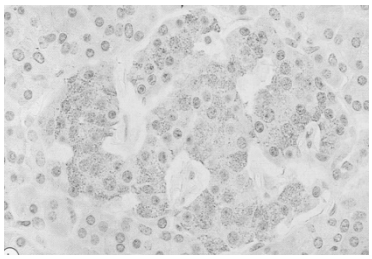
A. Pancreatic islet with immunohistochemistry stain for β **cells** (cell cytoplasm stains brown)

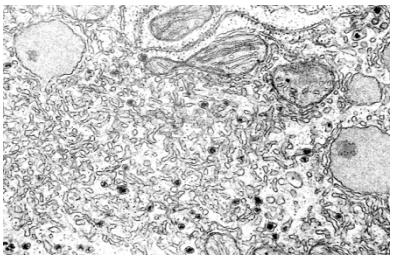




EM of liver

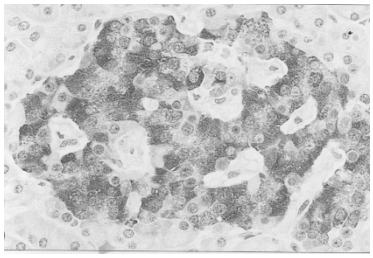
B. Pancreatic islet with immunohistochemistry stain for β **cells** (cell cytoplasm stains brown)

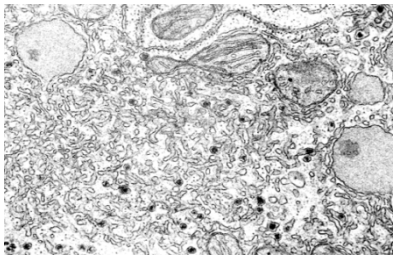




EM of liver

C. Pancreatic islet with immunohistochemistry stain for β **cells** (cell cytoplasm stains brown)





EM of liver

D. Pancreatic islet with immunohistochemistry stain for β **cells** (cell cytoplasm stains brown)

(707) responded that the number of sessions per year should increase or stay the same (data not included in Table 3).

Table 1: Evaluation of student performance

| | | |
|---|---|---|
| IRAT scores (total of 7) | | 20% |
| Group TBL scores (total of 7) | | 60% |
| GRAT scores | 20% | |
| Team application score | 40% | |
| Final Exam | | 20% |
| Total | | 100% |

Table 2. First-year medical student participants and response rates for student evaluation of the course

| | Pilot years | | | Stand Alone Course |
|---|---|---|---|---|
| Academic year | 2004-5 | 2005-6 | 2006-7 | 2007-8 |
| # of Students | 194 | 200 | 229 | 229 |
| Response Rate | | | | |
| Fall | 103 (53.1%) | 52 (26.0%) | 115 (50.2%) | 69 (30.1%) |
| Spring | 114 (58.8%) | 130 (65.0%) | 100 (43.7%) | 170 (74.2%) |
| Overall | 55.9% | 45.5% | 46.9% | 52.2% |

Following the introduction of a team-based final exam with the stand-alone course, students indicated in their evaluations that they enjoyed the format of the exam; 69.3% responded positively when asked if the final exam reflected concepts covered in the Clinical Applications sessions and 91.6% indicated that the team-based format was appropriate for the goals and objectives of the course. Written comments indicated that although the exam was challenging, students appreciated being able to utilize a group format to discuss the clinical problems and formulate a team response. Comments included: "The final exam was an excellent way to end the class. It was based on team work and figuring out medical cases with the help of peers." and "The final exam was actually an enjoyable experience because teams were left on their own to solve cases using available resources." The focus group presented similar conclusions to those of the on-line evaluation, while also highlighting ways to improve the administration of the course. For example, one suggestion was to use the format of the final exam for all of the sessions.

## DISCUSSION

Results from the inaugural year of the Clinical Applications course suggest that clinical problem-solving exercises presented in a TBL format are an effective method for both integrating basic science concepts taught in a traditional discipline-based curriculum and for the synthesis of

Table 3. Results from student evaluation of TBL clinical problem solving sessions

| Question | Pilot (3 years)[a] | | | Stand-alone Course[b] | | |
|---|---|---|---|---|---|---|
| | Positive | Neutral | Negative | Positive | Neutral | Negative |
| Exercises helped understanding of ICM material | 258 (42.0%) | 97 (15.8%) | 259 (42.2%) | 82 (34.3%) | 57 (23.9%) | 100 (41.8%) |
| Exercises helped understanding of basic science material | 364 (59.3%) | 82 (13.4%) | 168 (27.4%) | 117 (49.0%) | 35 (14.6%) | 87 (36.4%) |
| Exercises helped apply basic science principles to clinical situations | 468 (76.2%) | 60 (9.8%) | 86 (14.0%) | 174 (72.8%) | 24 (10.0%) | 41 (17.2%) |
| Pre-reading assignments useful in reviewing material for exercises | 48 (22.3%) | 34 (15.7%) | 134 (62.0%) | 106 (44.4%) | 28 (11.7%) | 105 (43.9%) |
| IRATS were useful learning activities | 45 (21.0%) | 30 (14.0%) | 139 (65.0%) | 55 (23.0%) | 34 (14.2%) | 150 (62.8%) |
| GRATS were useful learning activities | 111 (51.9%) | 33 (15.4%) | 70 (32.7%) | 145 (60.7%) | 25 (10.4%) | 69 (28.9%) |
| Individual actively involved during each exercise | 526 (85.5%) | 33 (5.4%) | 56 (9.1%) | 227 (94.6%) | 5 (2.1%) | 8 (3.3%) |
| All of team members actively involved during each exercise | 380 (74.7%) | 50 (9.8%) | 79 (15.5%) | 197 (82.1%) | 8 (3.3%) | 35 (14.6%) |
| Final exam reflected concepts similar to those covered in CA exercises | N.A. | N.A. | N.A | 117 (69.3%) | 19 (11.2%) | 33 (19.5%) |
| Team-based format of final exam appropriate to goals and objectives | N.A. | N.A. | N.A. | 154 (91.6%) | 8 (4.8%) | 6 (3.6%) |

[a] Values are the totals from the semester evaluations for the three-year pilot period. Some items were added when new components were added to the TBL sessions.
[b] Values are the totals from the semester evaluations for the first year as a stand-alone course. The items regarding the final exam were only asked after the second semester

information in solving patient-related problems. Overall, the format of the course easily accommodates a large number of students while supporting a congenial small group atmosphere with willing faculty as facilitators[21] giving the students a patient-centered, case-based, early learning opportunity.[22] The format fosters and emphasizes student-student interactions and active student participation, with appropriate faculty-student interaction during which clinical faculty often relate personal experiences in dealing with clinical cases similar to those being discussed. In retrospect, the course provided a "relaxed" atmosphere, often allowing for humorous aspects of cases to complement the serious nature of clinical presentation and therapeutic interventions. The end result was to reinforce basic science concepts, providing a novel mechanism to attain teaching objectives.

Results from the student surveys suggest that the primary goal of developing the ability of first-year medical students to apply basic science principles to the solution of clinically related problems was successful. That fewer students thought the sessions were useful in helping them understand the concepts presented in the basic science courses and in their ICM class is not totally unexpected owing to the nature of the TBL method. Team-based learning sessions are designed to enable students to apply previously learned concepts and skills by solving problems related to those concepts and skills.[23] Primary comprehension of the informational content comes through individual study of the material presented in the didactic and skills sessions. Despite the results of the student evaluation, we would argue that if the exercises helped students apply basic science principles in solving clinical problems, they also helped the students to gain an increased understanding of those principles.

An interesting observation is the discrepancy in the student perceptions of the usefulness of the IRAT and GRAT as learning activities. It suggests that the students perceive the IRAT as purely summative in nature, whereas, through team discussion and construction of a consensual answer, the GRAT helps them to correct misconceptions and increase their comprehension of the material being tested. Since the average GRAT score is universally higher than the average IRAT score (data not shown), it appears that many students do indeed learn from team discussions of the quiz items.

A somewhat surprising outcome (from data in Table 3, written comments and focus group responses) was the number of students that perceived pre-reading as an "extra" or "superfluous" task that would be better received as part of the actual lesson. This may reflect the heavily weighted didactic lecture-based format of the first-year curriculum at UTMSH, as well as the inexperience by students of this teaching modality. It is possible that students may wait to read assigned texts or syllabi until after a lecture is given in an attempt to review material and integrate this with their lecture notes. Another surprising outcome was the relative success of traditional, compared to modern, educational methods and technologies. PowerPoint® presentations were initially used as the primary tool in presenting the case scenarios and group application exercises, and we tried using an audience response system for simultaneous reporting of answers by all the teams. We discovered however, that hardcopy paper case scenarios and application exercises led to better sessions, better student-student and student-faculty interactions and exchanges, and better resolution of disagreements among students. The change in format to the paper cases facilitated a more collaborative atmosphere allowing for a better overall experience for both the overloaded students and the time-constrained faculty. PowerPoint® presentations are still used, albeit as an adjunct learning tool, to help in the clarification of particular teaching points. The return to the use of response cards for teams to report their answers eliminated technical difficulties that occasionally arose with the audience response system and the tendency for students to "play" with the clickers or race to be the first to respond rather than fully discussing the problem.

This integrative, team-based learning course helps satisfy our goals of improving student communication skills and their ability to work in a team as a cohesive unit in understanding and solving clinically related problems. The course incorporates a student-centered philosophy, via TBL and self-study, while keeping some of the traditional didactic and pen-on-paper methods of teaching and learning. It also presents material that is immediately relevant to the student learning, understanding and development as physicians in training and combines concepts from multiple sources into a concise, consolidated, well-received course that fulfills the medical school's mission of integrating basic science concepts into clinical problem solving.

While Clinical Applications maximizes small group learning within a large group setting, it requires a high-level of faculty dedication and administrative support. Specifically, the faculty time commitment to the course is large (meeting weekly to discuss and plan cases, as well as attendance at all of the exercises) and heavy administrative support is required for implementation of the sessions and collation and correlation of cases, exams and grades. Nevertheless, the time invested has fostered increased communication between all first-year course directors and has encouraged more integration within the first-year curriculum as a whole. The impact of this course on the students' application of basic science principles to clinical situations when they reach their required clinical clerkships remains to be measured. The students who experienced Clinical Applications during the 2007 academic year will begin their clinical clerkships in 2009. Therefore, another critical assessment of the course design will be the overall impact of this course on the medical education, training and competence of these students.

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