JIAMSE

Journal of the International Association of Medical Science Educators

Volume 15 Number 1 2005

IAMSE

Videotaped Case Presentations

Active Learning Strategies

Virtual Reality Simulation

Scientific Drivers to Enhance Understanding

IAMSE on the Web
www.iamse.org

ISSN: 1550-8897

JIAMSE

The Journal of the International Association of Medical Science Educators

Volume 15 | Number 1 | 2005

Role of IAMSE in the Council of Academic Societies (CAS): Report from the Spring 2005 CAS Meeting

Aviad Haramati, Ph.D.
Past President, IAMSE and IAMSE representative to CAS

Several years ago, the Board of Directors of IAMSE accepted an invitation from the Association of American Medical Colleges (AAMC) to consider applying for membership in the Council of Academic Societies (CAS), and in 2002 we were admitted as a member society (one of only 18 societies in Basic Science). The CAS meets formally each spring for 2-3 days and also gathers for a business meeting luncheon at the annual AAMC meeting each November. President Giulia Bonaminio and I serve as IAMSE's representatives to CAS, and I have had the honor of attending each CAS meeting since IAMSE became a member.

What exactly is CAS and what does it do? The CAS is one of three governing councils of the AAMC, along with the Council of Deans (COD), and the Council of Teaching Hospitals (COTH). CAS is composed of faculty leaders of U.S. medical schools and teaching hospitals through representation from 94 member professional organizations. The mission of the CAS is to help faculty members at academic medical centers meet their responsibilities of education, research and patient care, with the ultimate objective of improving the health of all Americans.

To accomplish its mission, the CAS is committed to the following goals (see the CAS website for full summary http://www.aamc.org/members/cas/about.htm):

- To analyze information pertinent to the core values of faculties and constituent societies and support their efforts to advance those values;
- To articulate the role of medical school faculty to academic medicine and to the public;
- To foster networking among scholars;
- To ensure that the CAS represents the broad interests of academic faculty and that constituent societies play an actual role in the CAS.

By participating in CAS activities, IAMSE's representatives can bring our members perspectives to the issues discussed at CAS and help insure that our voice helps shape the future direction of academic medicine.

There are a number of CAS Task Forces and projects underway that may interest IAMSE members. ***The CAS Task Force on the Impact of Dual-Degree Programs, Students and Faculty*** explored the impact of dual degree programs on the medical school enterprise. The final report discusses the Task Force's observations about the data it reviewed, and makes recommendations to AAMC staff and governance. A copy of the report is available from the AAMC website.

The CAS Scholarship Dissemination Project seeks "to provide faculty, staff and students in AAMC member schools, as well as members of CAS Societies, with a clearer picture of the significant changes that are taking place in the medical and biological sciences as scholarly communication moves from predominantly print to online electronic journals." Gary Byrd, Ph.D. and Shelley Bader, Ph.D., are leading the project. A database with basic bibliographic, pricing and subscription data for the 101 print and/or electronic journal titles currently published or sponsored by CAS member societies has been completed, and a follow-up survey of society executives and journal editors is in progress.

The Basic Science Chairs Leadership Forum was established to provide a voice to the basic science chair societies. The forum organized the 2002 national meeting of basic science chairs, and is now scheduling the next national meeting to be held in October 2005 in Salt Lake City, UT.

Lastly, a new set of Web-based tools has been created for CAS member societies. New resources for chairs, program directors and clerkship directors are now available on the CAS's password-protected site. We are looking for ways to make those resources available to IAMSE members.

The Medical Educator's Resource Guide

John R. Cotter, Ph.D.

The websites reviewed in the Medical Educator's Resource Guide are recognized by our reviewers as sites that can be used by medical educators and students for instruction and learning of the medical sciences. Nonetheless, before deciding to augment a course with an additional instructional tool, some thought should be given to the way a website or list of websites fits into the overall instructional plan of a course. It also helps to understand what prompts a student to use a site that has been recommended as a supplement to the instruction provided by an instructor.

Ali Ahmed, Stephanie Andrus and Helen Choi attend the University at Buffalo. At this stage in their training, they are about to complete the first year of medical school. The courses they have taken include gross anatomy, organ/system modules that integrate clinical knowledge and basic sciences and courses that teach clinical skills and emphasize problem solving.

In discussing with them the circumstances and factors that prompt a student to use a website, it is apparent the learning style of an individual has a lot to do with the extent to which a website or for that matter the Web is used for learning. Mr. Ahmed, for example, says websites can expand or reinforce concepts taught in class but are not all organized in ways that facilitate his learning or needs. Moreover, he contends searching the World Wide Web for images and information is faster and more productive than searching a website for specific bits of information.

According to Ms. Andrus, the most useful websites are those with images or those that help with understanding medical facts and clinical cases. One such site—eMEDICINE—which Ms. Andrus reviews below is a case in point. Another website-WebPath - which Ms. Choi favors for its images and case studies, was reviewed in an earlier edition of the Guide.

No one however uses the Web extensively. Mr. Ahmed points out his instructors offer more than enough in the way of learning materials. The time spent on a website therefore has a lower priority than that given to lecture notes, reading assignments, textbooks, laboratory exercises and other materials. So, rather than provide students with long lists of websites, he suggests instructors limit the number of websites to one or two that mirror the content of a course. And according to Ms. Choi, instructors should stress the importance or usefulness of the sites in learning the material presented in a course. The implication is that students are more likely to use them, if they do.

The comments of all three first year medical students indicate learners need much more than a list of websites appended to a course's webpage. Although students each have different approaches to learning, they are looking for the most efficient means of learning, communicating and doing well on examinations. Given the freedom of creativity permitted by the Web, the difficulty for users, of course, is in finding a website that matches their needs. The role of an instructor is to provide some direction. This can be done by drawing their students' attention to a site, emphasizing the importance of a website and explaining how the subsections of a website specifically fit the instructional goals of a course.

If you are aware of a website that has the potential for being used by educators and students of the medical sciences, please consider contributing to the Guide. Instructions for submitting a review may be found at http://www.iamse.org/jiamse/author_info.htm. *Send all submissions to* jrcotter@buffalo.edu.

American Association of Anatomists. Bethesda, Maryland.
http://www.anatomy.org/

The American Association of Anatomists (AAA) has created a website with excellent resources for anatomy educators and students. In the **Education and Teaching Tools** portion of the website, questions may be posted to experts in the "Ask the Expert" section. Previous questions and answers may be reviewed by exploring the categories listed as body region, organ/body system, development, histology and neuroanatomy. Another area of interest designed specifically for educators is the "Exam Question Database." The user must obtain a password to enter this section but this is a simple procedure involving a quick email to AAA describing what and where you teach. A prompt email response gives the educator the password necessary for using the exam question database which contains exam questions listed under the following headings: NBME, Body Region, Tissue Type and Discipline. The site's "Virtual Organ Image Library" offers links to more than thirty websites and movies featuring pathologic, radiographic, cross sectional and gross anatomical animations and digital images. The format of the website is concise and easy to navigate and should prove to be useful to students as a resource to supplement classroom learning and professors for in-class demonstration and sample exam questions. *(Reviewed by Pamela Stein, D.M.D., University of Kentucky Chandler Medical Center, Lexington, KY.*)

eMedicine. Instant Access to the Minds of Medicine.
http://www.emedicine.com

eMedicine is used commonly by medical students due to the wide range of clinical information that can be found in one easily accessible location. Although this internet resource is not as in depth as some written literature, it serves as a clinical guide for students covering a broad spectrum of topics. Medical students need to acquire and become familiar with much information while in medical school so it is convenient to have a reputable peer reviewed resource for clinical information. The website is also appropriate for health care providers and patients. A user can find articles, images, continuing medical education information and general background information with a search tool. Just type in the name of a disorder and you can choose from articles written from the perspectives of many different fields (e.g. pediatric or adult medicine). The articles generally contain many different topics including the author information, an introduction to the disease, the clinical manifestations of the disease, possible differentials (with links to more information about that particular diagnosis), a general work up, treatment options, specific medications, follow up information, some miscellaneous information and a bibliography. The website is free but a user name and password are required before the site can be entered. Once registered, the company personalizes the website based on whether you are a health care professional (includes your specialty), a student in the health related professions or a patient/consumer. Registration offers free personalized, specialty or consumer information, free educational updates, as well as CME/CE/CEH credits and picture database access. In summary, this website has been of great help to my classmates and me in assisting us in our school's case-based curriculum. (*Reviewed by Stephanie Andrus, B.A., University at Buffalo.*)

Histology Home Page. Paul B. Bell, Jr. and Barbara Safiejko-Mroczka.
http://casweb.cas.ou.edu/pbell/Histology/histo.home.html

This site services a histology course in the Department of Zoology at the University of Oklahoma. Potential users should visit The "Virtual Histology Lab" and "Self-Tests - Menu". The virtual laboratory deals with several practical matters: the operation and care of a microscope, staining methods and the appearance of the actual tissues and organs used by the students in the course. The section on staining methods is instructive because it illustrates how different dyes are used to demonstrate different cell structures. Visitors interested in the self-testing aspect of the site can check to see if they are able to identify structures and answer fact-based lecture/textbook-based questions. (*Reviewed by John R. Cotter, Ph.D., University at Buffalo.*)

ThJuland's MSer's Glen.
http://members.tripod.com/~ThJuland/

This website is maintained by a multiple sclerosis (MS) patient. The site allows you to explore the central nervous system (CNS) with respect to the clinical side of MS and other CNS issues such as traumatic brain injury. It addresses the anatomy and functions of various CNS structures and areas of interest to the MS patient. It contains links to over 20 textbooks and a glossary of relevant terms. In addition, there is a lengthy list of publications and abstracts dealing with multiple sclerosis and the CNS. The website is a great place for information about MS and the nervous system. It contains no interactive slides or study questions, but due to the abundance, extensiveness and accessibility of the information, educators will have no problem finding questions for tests or clarifying concepts regarding the CNS. The site contains the patient's history and test results as well as links to other Internet sources for many different types of CNS related problems. There is also a forum for patients. This website makes it easier for students and educators alike to find sufficient information, efficiently. *(Reviewed by Janelle Reed, B.S., University of Kentucky*.)

COMMENTARY

Guided Discovery Learning with Videotaped Case Presentation in Neurobiology

Robert A. Lavine, Ph.D.

Department of Pharmacology & Physiology
The George Washington University School of Medicine and Health Sciences
Washington, DC 20037 U.S.A.

Phone: (+)1-202-994-3550 Fax: (+)1-202-994-3553 Email: phyral@gwumc.edu

ABSTRACT

Research in psychology and education with students at the pre-college level suggests that guided discovery learning is superior to the less-structured approach of pure discovery learning in promoting learning and knowledge transfer.[1] In medical education, guided discovery learning is a learner-centered approach that combines didactic instruction with more student-centered and task-based approaches.[2] Key features are (1) a framework for student learning, (2) student responsibility for exploring content needed for understanding, (3) study guides provided, and (4) application to clinical or experimental problems. This paper describes an example from an interdisciplinary neurobiology course for first-year medical students. Following didactic presentations of nervous system structure and function, we present an introduction to the clinical case, an outline of the neurological examination, and assignment of a written report. Study resources are provided. This is followed several days later by the presentation of a videotaped case of a patient admitted with a stroke one year ago, with a neurologist taking the history and reviewing the examination at admission. Each segment was followed by the instructor, a member of the neurology faculty, questioning students and inviting discussion on differential diagnosis based upon their knowledge of neuroanatomy and neurophysiology. Students were asked to evaluate this component of the course on a 1-6 Likert rating scale (1=strongly agree to 6=strongly disagree). 79 to 88% strongly agreed or agreed that it "increased my knowledge of neurobiology", "increased my motivation to learn neurobiology", "increased my ability to apply neurobiology to clinical problems", and "improved my understanding, motivation to learn, and/or ability to apply neurobiology more than a typical lecture". An objective performance measure is cited as an approach to the effect on learning. The results suggest that the clinical case presented by means of guided discovery learning serves to focus on real problems and adds relevance and motivation to mastery of related basic science information.

INTRODUCTION

Guided discovery learning combines didactic instruction with more student-centered and task-based approaches.[2] Key features are (1) a framework for student learning, (2) student responsibility for exploring content needed for understanding, (3) provision of study guides, and (4) application to clinical or experimental problems.

Influential voices in the fields of psychology and education describe learning as an active process in which the learner constructs coherent and organized knowledge.[1] This view has been referred to as the constructivist view of learning. It contrasts passive instructional methods such as lectures and books with constructivist methods such as group discussions and hands-on activities. Educators have been encouraged to allow students to discover rules and ideas and to solve problems, often in groups, with little guidance. However, Mayer[1] describes several groups of educational studies that cast doubt on the wisdom of this belief.

One group involved comparing pure discovery methods with little guidance; guided discovery methods, in which the student solves problems but the teacher gives some coaching and/or feedback; and expository methods, in which the student is provided with the correct answer along with the problem. Problems used were logical reasoning tasks of identifying a word that does not belong in a list of other words, or deriving arithmetic formulas. The guided discovery groups were found to perform best by the criteria of retention and transfer to solving new problems. Another group of studies was stimulated by Papert's[3] argument that children working in his LOGO environment should discover computer programming concepts on their own without the intervention of teachers. Subsequent studies, however, showed that students who learned in this manner did not generalize this learning to related tasks, and that guided discovery methods involving modeling by the teacher was more effective in teaching students to write programs. Mayer concludes from these studies that guided discovery learning is superior to the less-structured approach of pure discovery learning in promoting learning and knowledge transfer.

How can these arguments be related to medical education? In their review of learner centered methods in medical education. Spencer and Jordan [2] begin by asserting that self-directed learning, in which the student is an active participant, encourages a deep approach to learning, that involves an active search for understanding, rather than a surface approach to learning that encourages students to repeat what has been learned. They review several strategies for self-directed learning, including problem-based learning, guided discovery learning, task-based learning, and small-group learning. Problem-based learning (PBL) is seen as promoting deep rather than surface learning, in a more stimulating learning environment, with greater student-faculty interaction, in a manner that promotes knowledge retention and motivation. However, it can have such drawbacks as excessive startup and faculty time, relative inefficiency, less acquisition of basic science knowledge, and implementation difficulties in large classes.

Guided discovery learning combines the best of traditional modes of medical education with more innovative and learner-centered methods.[2] Usually within an integrated, system-based curriculum or course, a learning framework and objectives (or outcomes) are presented by didactic teaching methods. Students are responsible for exploring the content necessary through self-directed learning, with the help of study guides that are provided. Application to real clinical problems, with discussion, reinforces understanding and motivation.

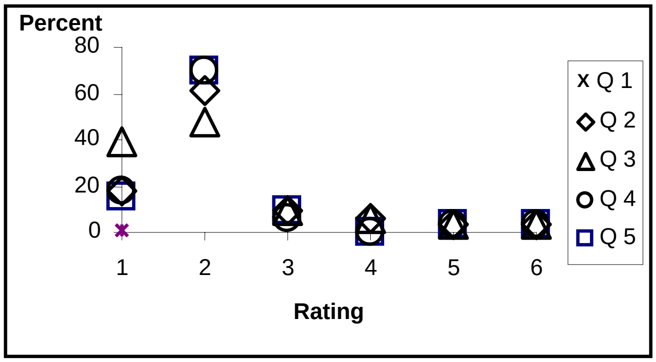
EXAMPLE

A clinical case study will be described as an example of guided discovery learning developed for the interdisciplinary neurobiology course for first-year medical students directed by the author. This is inserted in a mostly lecture-based course following didactic presentations on nervous system structure and function up to and including the cerebral cortex, and is followed by additional lectures. A lecture and handout introduces the goals, especially the ability to apply neuroanatomy and neurophysiology to real clinical cases and to write a summary of how this case can be explained on the basis of neurobiological knowledge. The lecture then gives a preview of the case to be presented on videotape, including presenting problems, history, neurological examination, and differential diagnoses. An outline of the components of the neurological examination is presented, with the categories mental status, cranial nerves, motor and sensory systems, reflexes, cerebellar, and gait, with reference to how these categories can be related to topics already presented. The requirement for each student to write a one-page report of the diagnosis in terms of neuroanatomy and neurophysiology is then assigned. Students are shown a brief preview of the videotape, and assigned to learn the topics introduced with the help of the course textbook and an internet-based resource.[4]

Approximately one week later, the class meets under the guidance of a member of the neurology faculty, either as a whole or divided into smaller groups. The videotaped case presentation shows a patient admitted with a stroke one year ago, with a neurologist taking the history and reviewing the examination at admission. Each segment is followed by questioning students and discussion on differential diagnosis based upon their knowledge of neuroanatomy and neurophysiology. The beginning of the video shows a patient who one year earlier had an acute onset of hemiparesis, visual field loss, astereognosis, and denial of the severity of his illness. The videotape is then stopped and the class asked to list the presenting problems and then to generate hypotheses for the nature and cause of the problems. Class discussion is open but with guidance and feedback from the instructor. The next segment of the video is then shown. This includes brain (CT) scans and treatment with a thrombolytic agent. Again, the video is stopped and class discussion ensued. The site of the lesion is discussed, and how it might account for the presenting problems. The clinical course with complications followed by recovery is then shown and discussed. Finally, a follow-up neurological examination, showing few residual signs or symptoms, is shown and discussed. Each student submits a one-page printed report after 7-10 days. Grades are assigned based on how well the patient's problems are explained in terms of neuroanatomy and neurophysiology.

To begin to address the value of this instructional method in order to focus on real problems and add relevance and motivation to mastery of related basic science information, students were asked three months after the conclusion of this course to evaluate components of the course on a 1-6 Likert rating scale (1=strongly agree to 6=strongly disagree). 85% strongly agreed or agreed that it "increased my knowledge of neurobiology" (mean rating 2.18, SD 0.27, n=33), 79% that it "increased my motivation to learn neurobiology" (mean rating 2.24, SD 0.22), 88% that it "increased my ability to apply neurobiology to clinical problems" (mean rating 1.82, SD 0.22), and 88% that it "improved my understanding, motivation to learn, and/or ability to apply neurobiology more than a typical lecture" (mean rating 2.09, SD 0.27). Figure 1 (Ratings of students for instructional method using videotaped case) illustrates these responses.[1] In a more general student evaluation of the course as a whole given nearer the conclusion of the course, 55% strongly agreed or agreed that "recommended texts and/or instructional methods were effective in promoting my learning" (mean rating 2.55, SD 0.16, n=65. Differences in sample size and administration do not allow direct comparison of these ratings, but they do suggest that this instructional method was generally well-regarded.

Figure 1. Ratings of students for instructional method using videotaped case.



Number of questionnaires returned was 33. Q1: "increased my knowledge of neurobiology", Q2: "increased my motivation to learn neurobiology", Q3: "increased my ability to apply neurobiology to clinical problems", and Q4: "improved my understanding, motivation to learn, and/or ability to apply neurobiology more than a typical lecture". Ratings were 1 = strongly agree, 2 = agree, 3 = somewhat agree, 4= somewhat disagree, 5 = disagree, and 6 = strongly disagree; class size = 163.

To begin to address the value of the module for improving knowledge, understanding, retention, and transfer of knowledge, results for the four examination questions based on a clinical vignette that also required application of basic science knowledge to a cerebrovascular disorder at the cortical level, but not that same as the topic of the videotaped clinical case, shows that the percent of the class giving correct answers was 98%, 86%, 95%, and 100%, compared with 85% correct for the examination as a whole. Results suggest a possible positive value of the method for the goals of knowledge and understanding.

Discussion

Guided discovery learning is a learner-centered approach that combines didactic instruction with more student-centered and task-based approaches. Studies in educational psychology of younger students suggest that it is superior to "pure" discovery learning with little or no guidance. In medical education, it also allows the problem-based approach to be incorporated into a lecture-based course for a larger class of students.

The example described here suggests that the clinical case presented by means of guided discovery learning serves to focus on real problems and adds relevance and motivation to mastery of related basic science information. In comparison to traditional lectures, it has the potential of greater involvement of the student in exploring the topic through self-directed learning reinforces understanding through application to a real clinical problem provides role models for clinical application of basic science information, and provides an opportunity for synthesis and written expression.

Preliminary results presented can be regarded as limited and anecdotal, but general agreement by students that this instructional method helps to focus on real problems and add relevance and motivation to mastery of related basic science information. In addition, examination questions based on a different clinical vignette that also required application of basic science knowledge to a cerebrovascular disorder at the cortical level suggests a possible positive value of this method for the goals of improving knowledge and understanding.

In comparison to problem-based learning in small groups, this instructional method has been less demanding on student and faculty time and less likely to reduce the time available for more traditional teaching modes. It has required sufficient preparation and collaboration between basic scientists and clinicians to produce a high-quality videotaped case, although the availability of similar internet-based case resources may make this component easier. It has also required faculty effort in reading and scoring written reports. This component presented at different times in small to medium sized groups, facilitated by neurology residents, and the class as a whole, facilitated by an experienced clinician-educator. Small groups provided more opportunity for student participation, but the uneven quality of instructors and difficulty in scheduling them was found to be a challenge.

Although PBL in small groups has often been contrasted with more conventional lecture-based learning (LBL) in medical education, variants of the PBL method have also been described for larger groups or combined with a lecture-based format. When a variant of the PBL method was applied in a medical biochemistry course to a larger group of students, student performance in a multiple-choice test did not show a significant difference between PBL and LBL, but PBL produced significantly higher student ratings in such areas as study time, enthusiasm, group discussion, and depth of knowledge.[5] Methods of enhancing learner participation within a lecture format have been described that include clinical examples, questioning of students, recruiting students to solve "mystery cases", and asking students to help summarize key points.[6] The example described in this paper incorporated the methods of videotaped case presentations, self-study guides, class discussion, and written reports with the goal of providing the advantages of guided discovery learning in combination with an overall lecture-based format.

In conclusion, an instructional method using guided discovery learning with videotaped case presentation in a medical neurobiology course shows promise as a step to meet the objectives of improving motivation to learn neurobiology, understanding, retention, and transfer of knowledge, and application of basic sciences to a clinical problem. Future research needs to be conducted with larger-scale evaluation of the effects of this method on both subjective student responses and objective performance.

References

1. Mayer, R.E. Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist.* 2004; 59: 14-19.
2. Spencer, J.A. and Jordan, R.K. Learner centred approaches in medical education. *British Medical Journal.* 1999; 318: 1280-1282.
3. Papert, S. Mindstorms: Children, computers, and powerful ideas. New York: Basic Books, 1980.
4. Martin, J.B. and Hauser, S.L. Approach to the patient with neurological disease. Retrieved March 10, 2004 from Harrison's Online, McGraw-Hill Companies. Web site: http://harrisons.accessmedicine.com.
5. Khan, I. and Fareed, A. Problem-based learning variant: transition phase for a large institution. *Journal of the Pakistan Medical Association*. 2001; 51(8): 271-274.
6. Nierenberg, D.W. The challenge of "teaching" large groups of learners: strategies to increase active participation and learning. *International Journal of Psychiatry in Medicine*. 1998; 28(1): 115-122.

COMMENTARY

The Value of Scientific Drivers to Enhance Learning for Basic Science Clinicians, Faculty, and Students

L. K. Gunzburger, Ph.D.

Department of Family Medicine
University of Illinois at Chicago
24520 W. Janet Lane
Channahon, Illinois 60410 U.S.A.

Phone: (+)1-815-521-1897 Fax: (+)1-815-521-1899 Email: gunzburger@worldnet.att.net

Diabetes mellitus currently affects 17 million people in the United States, with the vast majority, 8% of the adult population, having Type 2 Diabetes Mellitus (T_2DM). It has become epidemic in the past several decades due to the advancing age of the population, increased prevalence of obesity and decreased physical activity. Diabetes causes considerable morbidity and mortality. The major complications are related to the micro- and macrovascular complications of the disease. The major macrovascular complication is atherosclerosis with an increased risk of a cerebrovascular accident and/or a myocardial infarction. The major microvascular complications are retinopathy, nephropathy, and neuropathy. Type 2 diabetes contributes to more cases of adult onset loss of vision, renal failure and amputation than any other disease. Patients with Type 2 diabetes have two to four times the risk of cardiovascular disease and 70% die of cardiovascular disease.[1]

The scientific literature was examined and key points abstracted as scientific drivers for learning and enhanced patient care. With a national advisory board and unrestricted grant support, five T_2DM scientific drivers were stated. A scientific driver is a brief statement based on the most current medical literature, medical faculty review, clinicians' approval, and consensus statement of U.S. medical specialties. Scientific drivers usually focus on therapeutic areas. The drivers for T_2DM were defined as:

- **Driver One -** Reducing blood glucose levels and HbA1c levels reduces the risk of diabetic complications. Intensive therapy has been shown to be superior to conventional therapy in terms of reducing glycemia and diabetic complications.
- **Driver Two** - When monotherapy with an oral agent is no longer adequate, combination therapy with 2 or more oral agents has been shown to significantly improve glycemic control.
- **Driver Three -** When oral monotherapy or combination oral therapy is no longer adequate, insulin can be added to the regimen to significantly improve glycemic control.
- **Driver Four -** Benefits of insulin therapy, such as improved outcomes and glycemic control, outweigh risks such as the potential for inducing hypoglycemia.
- **Driver Five -** Type 2 Diabetes Mellitus is a disease consisting of two components, insulin resistance and insulin deficiency.

A case-based learning module was written as part of the project. Priority groups are basic science faculty and students, clinical faculty, clinical students, and clinicians. U.S. medical schools were surveyed to determine the extent to which the five drivers were taught in Years 1, 2, 3, or 4. The five drivers seem to integrate the learning across the curriculum.[2] The clinical faculty each teach the treatment of T_2DM, the oral hypogenic agents, and the side effects of these drugs instead of insulin.

According to the Association of American Medical Colleges' (AAMC's) CurrMIT [3] database, 58 medical schools report the teaching of diabetes at some point during the basic sciences or clinical years. Although some have integrated basic sciences and clinical materials, there remains a deficiency on how schools view scientific evidence based medicine content for T_2DM. Examples of doing so may be found in the CurrMIT database. U.S. medical schools have an assigned password from the Association of American Medical Colleges to access this data.

In interviews with faculty, it was suggested that T_2DM could be better taught in a coordinated and integrated manner that spans the four years of medical school. At this time, however, it appears that in most cases they are only being taught in single courses. It does not appear that they are being taught across all four years of medical school. Faculty may select the order of the drivers and perhaps begin with driver 5, learning about pathology conditions first. Biochemical parameters (driver 2) and pharmacological treatments (driver 2, 3, and 4) could follow. The intent of this curriculum should provide the students an appropriate knowledge base to adequately treat patients.[4]

A poster presentation was provided attendees at the July 2003 International Association of Medical Science Educators annual meeting held at Georgetown. Several schools had extensive diabetes curriculum and formally commented about the intrinsic value of the five drivers. A summary of the schools that are successfully teaching the five drivers is listed in Table 1, "Schools Teaching T_2DM Scientific Drivers." A summary table of the schools' representatives attending the July 2003 International Association of Medical Science Educators was developed from interviews and written surveys of the attendees. The attendees participated voluntarily. The results of these 18 representatives is summarized in Table 1, "Schools Teaching T_2DM Scientific Drivers." Based on interviews, the drivers are not taught in most of health sciences institutions internationally. There were 18 institutions where most of the drivers are taught. The best examples for the health sciences are listed in the table. These institutions serve as role models.

Summary of Table 1	
Driver 1	18 out of 18
Driver 2	18 out of 18
Driver 3	17 out of 18
Driver 4	13 out of 18
Driver 5	16 out of 18

The T_2DM health crisis can be improved by these learning activities. The five drivers are based on scientific evidence based medicine and can facilitate curriculum planning, integration, deployment, and evaluation. However, it is suggested basic science and clinical faculty learning teams be assembled to address chronic and end stage disease states. For each of these conditions, scientific drivers can be identified to guide integrated learning, curriculum and assessment across therapeutic areas.

REFERENCES

1. Winer, N. Sowers, Jr. Epidemiology of Diabetes. *Journal of Clinical Pharmacology*. 2004; 44: 397-345.
2. Norris, T., Cullison, J.W., and Fihn, J.D. Teaching Procedural Skills. *Journal of General Internal Medince.* 1997; 12 (suppl2) S64-S70.
3. Association of American Medical Colleges CurrMit Database. Washington, D.C. 2003.
4. Gunzburger, L. Integrating Basic and Clinical Sciences via Type 2 Diabetes Mellitus. 7th Annual Meeting of the Int Assoc Med Science Educators. July 19-22, 2003. Washington, D.C. U.S.A.

TABLE 1. Schools Teaching T_2DM Scientific Drivers

College	Driver	Driver Being Taught?	Course(s)
U of Nebraska College of Medicine	Driver One	Yes	Pharmacology
	Driver Two	Yes	Pharmacology
	Driver Three	Yes	Pharmacology
	Driver Four	No	Should
	Driver Five	Yes	
U of Texas Medical Branch , Galveston, TX	Driver One	Yes	Molecules, Cells, Tissues, Endocrine
	Driver Two	Yes	Molecules, Cells, Tissues, Endocrine
	Driver Three	No	Should/Endocrine
	Driver Four	No	Should
	Driver Five	Yes	Molecules, Cells, Tissues, Endocrine
Brody School of Medicine	Driver One	Yes	Biochemistry; Physiology; Pharmacology
	Driver Two	Yes	Pharmacology
	Driver Three	Yes	Pharmacology
	Driver Four	No	
	Driver Five	Yes	Pharmacology
U of Health Sciences (Kansas City)	Driver One	Yes	Endocrine
	Driver Two	Yes	Endocrine
	Driver Three	Yes	Endocrine
	Driver Four	Yes	Endocrine
	Driver Five	Yes	Endocrine
U of Oslo, Norway	Driver One	Yes	Semester 2-Cell Biology Semester 4-G1-tractus
	Driver Two	Yes	Semester 4
	Driver Three	Yes	Semester 4
	Driver Four	Yes	Semester 4
	Driver Five	Yes	Semesters 2 & 4
Sackler School of Med. Tel-Aviv U	Driver One	Yes	
	Driver Two	Yes	
	Driver Three	Yes	
	Driver Four	Yes	
	Driver Five	Yes	
Florida State University	Driver One	Yes	Pathology, Doctoring
	Driver Two	Yes	Pharmacology
	Driver Three	Yes	Pharmacology
	Driver Four	Yes	Pathology
	Driver Five	Yes	Pathology
Drexel U College of Medicine	Driver One	Yes	Year 1 Biochemistry
	Driver Two	Yes	Pathology Pharmacology
	Driver Three	Yes	Biochemistry
	Driver Four	Yes	Biochemistry
	Driver Five	Yes	Biochemistry
UMDNJ-RW Johnson Medical Schoo	Driver One	Yes	Biochemistry
	Driver Two	Yes	Biochemistry
	Driver Three	Yes	Biochemistry
	Driver Four	Yes	Biochemistry
	Driver Five	Yes	Biochemistry; Physiology

College	Driver	Driver Being Taught?	Course(s)
Lake Erie College of Osteopathic Medicine	Driver One	Yes	Endocrine System
	Driver Two	Yes	Endocrine System
	Driver Three	Yes	Endocrine System
	Driver Four	No	Endocrine System
	Driver Five	No	Endocrine System
Florida State U College of Medicine	Driver One	Yes	Biochemistry
	Driver Two	Yes	Pharmacology
	Driver Three	Yes	Biochemistry; Pharmacology
	Driver Four	No	
	Driver Five	No	
Southern Illinois University	Driver One	Yes	Year 2 Endocrinology (all drivers)
	Driver Two	Yes	
	Driver Three	Yes	
	Driver Four	Yes	
	Driver Five	Yes	
New York College of Podiatric Medicine	Driver One	Yes	Lecture
	Driver Two	Yes	Pharmacology Lecture
	Driver Three	Yes	
	Driver Four	Yes	Internal Medicine
	Driver Five	Yes	Lecture/Guest Lecture
East Tennessee State University	Driver One	Yes	Biochemistry; Physiology
	Driver Two	Yes	Biochemistry; Physiology
	Driver Three	Yes	Biochemistry; Physiology
	Driver Four	Yes	Biochemistry; Physiology
	Driver Five	Yes	Biochemistry
Indiana Univ School of Medicine	Driver One	Yes	Pharmacology, Physiology
	Driver Two	Yes	Pharmacology
	Driver Three	Yes	Pharmacology
	Driver Four	Yes	Pharmacology
	Driver Five	Yes	Pharmacology
Philadelphia. College Osteopathic Medicine	Driver One	Yes	Cell & Tissue
	Driver Two	Yes	Cell & Tissue
	Driver Three	Yes	Cell, Tissue & Pharmacology
	Driver Four	Yes	Cell, Tissue & Endocrine
	Driver Five	Yes	Cell, Tissue, & Endocrine
Texas Tech Univ Health Science Center	Driver One	Yes	Intro Clinical Medicine
	Driver Two	Yes	Pharmacology
	Driver Three	Yes	Pharmacology
	Driver Four	Yes	ICM Pharmacology
	Driver Five	Yes	Physiology
Loma Linda U, CA	Driver One	Yes	2nd Year Pathology; Pathophysiology
	Driver Two	Yes	2nd Year Pathophysiology; 3rd Year Medicine
	Driver Three	Yes	2nd Year Pathophysiology; 3rd Year Medicine
	Driver Four	Yes	2nd Year Pathophysiology
	Driver Five	Yes	2nd Year Pathophysiology

Active Learning Strategies in Undergraduate Medical Education of Pathology: A Saskatoon Experience

Rani Kanthan, M.B.B.S.[1] and Sheryl Mills, M.D.[2]

[1] Department of Pathology and [2]Educational Administration
Colleges of Medicine and Education
University of Saskatchewan
Room 2868 "G" Wing
Royal University Hospital
103 Hospital Drive Saskatoon, SK S7NOW8 CANADA

Phone: (+)1-306-655-2158 Fax: (+)1-306-655-2223 Email: rani.kanthan@sakatoonhealthregion.ca

ABSTRACT

Medical education continues to be primarily structured around faculty authority and lecture. This promotes individualistic competitive environments rather than the co-operative ones needed for "patient-centered medicine." In much the same way as one can decide to either purchase a new home outright or renovate an existing home to better meet needs, in this study we set out to renovate an existing home by exploring the inclusion of active learning strategies -- collaboration, metaphor and analogy, and summarization techniques --in a general pathology course within the traditional undergraduate medical curriculum framework. The aim was to create a collaborative classroom opportunity for analyzing, problem solving, summarizing, and using visual/verbal metaphors to explain complex medical concepts in a simple fashion. Through this participation, students earned 10% toward their final grade and received general immediate feedback on their submitted work. The inclusion of these strategies was evaluated through student performance on the midterm exam and by a questionnaire completed anonymously by all students at the same time. The student performance in the midterm exam was slightly higher than in previous years. Of the total number of 256 responses to the open-ended questions from the students, 170 (67%) were positive about the inclusion of these active learning strategies. Seventy-two responses were negative (28%) while 14 (5%) comments were neutral. Some students indicated that these strategies detracted somewhat from traditional lecture time or that analogy and metaphor were "too abstract." Based on feedback from students and observing student participation, we feel that these strategies, as a "renovation" of the traditional lecture-based undergraduate medical curriculum, "do no harm" and, in fact, contribute to learning and social interaction in the delivery of pathology. The long-term impact of using resonant analogies and metaphors to explain complex medical concepts to patients may only become apparent when these students are doctors in team-oriented, patient-centered clinical practices.

INTRODUCTION

Post-secondary education is changing; the postmodern generation wants fun, power in their own hands, clear expectations and explanations, personal rapport with their instructors, honesty, and uninhibited use of technology.[1] Students are "becoming more diverse in ethnic background, age, and participation patterns."[2] Current research on learning indicates that using a wide variety of teaching strategies in the classroom increases student buy-in and learning, but "because employing this emerging knowledge challenges the historic structure of the universities, we ignore it"[3] "This raises the question of whether it has already become immoral to teach without extensive use of active learning techniques that so enhance performance."[4] Learning and participation are inseparable.[5] In response to findings such as these, the professoriate is being encouraged to adapt and alter their teaching methods to address the new generation of postmodernist students.[1]

More specifically, there is a shift in medical education toward educating physicians who can work as team members; an ideal medical education would produce physicians who, as part of a health team, practice "patient centered medicine."[6] This education has remained elusive, perhaps, because it requires a change of philosophy from a disease-centered approach to an illness-centered approach, as well as an expectation for physicians to be members of health care teams (medical and non-medical trained personnel) responsible for patient management. Being a member of a team requires effective interaction and communication with all members of the team. Physicians-in-training require opportunities to develop these interpersonal skills that will be used throughout their careers

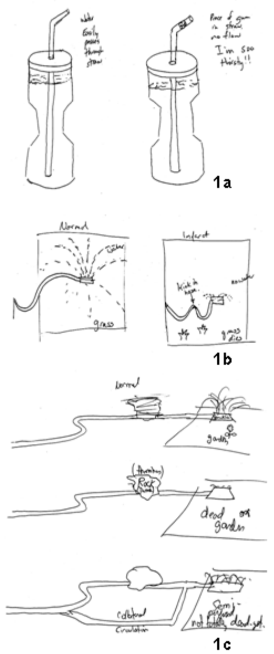


Figure 1. Visual Metaphors.
Working in groups, students were asked to represent the concepts of thrombosis/embolism-infarction using visual metaphors that drew on their personal experiences in order to simplify these complex concepts.

with both patients and team members as part of their hitherto traditional rigorous medical education. [7,8]

Active learning strategies are instructional tools that can address both content and process objectives that include the development of interpersonal, communication and problem-solving skills within the current framework and tradition of lecture-based classes. Dealing with the same content, students have an opportunity to both increase their grasp of the content while using processes that encourage interpersonal communication, teamwork, and problem solving. Active learning strategies are widely used in both elementary and secondary educational settings and in some post-secondary and adult education because they promote learning through the active participation of the learner; "teaching strategies and learning tasks used in university classrooms foster intellectual passivity because they focus on presenting knowledge, rather than constructing analyzing, synthesizing, or evaluating knowledge." [9] Teaching styles in medicine have remained fairly pedantic with traditional modernist classrooms structured around faculty authority and visual learning. Such traditional teaching continues to promote an individualistic, competitive environment rather than fostering the skills of cooperation necessary to function effectively as part of a team.

A vision for a progressive team approach to the management of patients has called for the active involvement of medical students in their own education and training. This promotes and provides opportunities for the development of the thinking skills and interpersonal skills needed to function effectively in this new environment. Active learning strategies that emphasize small group activities reinforce the content for which medical students are responsible by using strategies that address a wider variety of individual learning styles, and promote the development of effective team work and interpersonal skills through the processes of active learning.

The design and format of the study contribute unique ideas to the field of medical education; there is a collegial relationship between a medical faculty member and an education expert in an on going collaborative process, and students are experiencing strategies that will both presumably enhance their immediate learning and will provide them with techniques to use with patients in their future medical practices. More specifically, the purpose of this study was to evaluate the inclusion of three methods of active learning strategies (encouraging collaboration, using analogy and metaphor, and summarizing techniques) in the general pathology course of the undergraduate medical curriculum.

METHODS AND MATERIALS

The active learning strategies of using metaphor, collaboration, and summarization techniques including the fishbone technique were incorporated into a General Pathology Course. The specific teaching strategies chosen addressed both process and content of:

a) Developing and practicing interpersonal and communication skills;
b) Promoting a more cooperative atmosphere among individuals;
c) Providing opportunities for group problem solving;
d) Introducing and modeling a technique for conveying complex medical concepts in an accessible simple way for students to use in the future with their patients; and
e) Incorporating a wider variety of strategies linked to learning styles to help students understand the content more thoroughly.

The course ran from the end of August to the middle of December meeting 43 times in total, three times per week. This is a 6-credit course with 57 contact hours taught by 8 different instructors over the term. There were 88 students enrolled in this course: 60 2nd year medical students, 26 2nd year dental students, and 2 Masters in Pathology graduate students. This study was initiated and carried out by the course coordinator who was an instructor and taught 13 of the 22 classes; these sessions formed a block series of lectures occurring from the beginning of the course to the midterm exam thereby maintaining continuity of teaching style. Working with a doctoral student in Educational

Table1. Part C Midterm Evaluation/Reflection (2 Marks)

1 = Strongly Disagree; 2 = Disagree; 3 = Agree; 4 = Strongly agree

Circle response as per the following example:

1. I love Pathology

   1 2 3 4

---

1. The test material reflects the "Objective Criteria" for Path 301.6.

   1 2 3 4

2. The questions reflected the material taught.

   1 2 3 4

3. The questions were clear, unambiguous and of high quality.

   1 2 3 4

4. Part B questions help me demonstrate my knowledge in Pathology.

   1 2 3 4

5. I was prepared to answer the Part B question format.

   1 2 3 4

6. I enjoyed the challenge of answering the Part B format questions.

   1 2 3 4

Active Learning - Teaching Methodology

- Group Discussions/partner work
- Individual Quiz format
- Learning with/by an Analogy (Timbits)
- Learning with/by a Visual Metaphor
- Fish Bone Technique (Embolism/Shock)

7. I liked to participate. Yes ☐ No ☐

8. I enjoyed the social interaction/integration. Yes ☐ No ☐

9. This teaching methodology helped me to learn easily. Yes ☐ No ☐

10. Please indicate below a positive (+)/negative (-)/interesting (PNI) aspect of this approach of teaching methodology.

Positive (+) ______________________________

Negative (-) ______________________________

Interesting ______________________________

COMMENTS:

____

Administration, this instructor developed lessons that met the content and process objectives to be addressed by increasing the amount of active learning. The instructor and the coach worked together using action research cycles of plan, act, observe, and reflect [10] to decide which active learning strategies might be most effective in meeting the process and content objectives set by this instructor for her portion of the course. It was finally decided to use metaphor, collaboration and various summarization techniques including the fishbone technique. The instructor, an accomplished lecturer, excited by workshops offered for faculty in the College of Medicine to encourage more active learning in medical education, was keenly interested in developing a larger repertoire of instructional methodologies. The coach was interested in seeing if these methods could be used to advantage in medical education. Organizationally, the scholarship of teaching was encouraged in the College.

During the introductory session, students were informed that active learning strategies would be included in their familiar lectures in this instructor's classes. As an incentive beyond the benefits to their own learning and the development of skills that would stand them in good stead with future colleagues and patients, students were informed that participation in these activities would garner 10% of their final grade.

Rather than "buying" a completely new educational style, the instructor and the coach chose to start slowly by "renovating" the old traditional lecture with small bits of active learning strategies that usually took no more than 10 minutes in a 50-minute class. Lectures were punctuated and augmented with active learning strategies that often included working in pairs or small groups. Groups were formed randomly with proximity usually being the deciding factor; students turned to the person sitting closest, generally someone they already knew. Students were asked to discuss key points of portions of the lecture or formulate responses to questions posed throughout the lecture. This provided a break in the flow of lecture information, and gave students an opportunity to reflect and interact with their peers.

At other times, students were asked to develop visual or verbal metaphors that linked the pathology concepts being presented in the lecture to a common visual or verbal concept. The instructor modeled first and gave examples, and then provided an opportunity for students to develop their own metaphors in small groups or pairs. Figures 1a,b,c and 2 provide examples of how students used this technique to advantage. Exploring how various complex medical concepts compared to and are different from familiar concepts helped to cement the medical concepts for some and provided a model that could be used to clarify complex concepts with patients in the future. For some students, the visual metaphors had more impact, and for others, the verbal metaphors resonated more effectively. In both cases, there was an opportunity for the instructor to clear up any misconceptions about the medical concepts that may be illuminated as students developed metaphors. Working in pairs throughout the course, students used a variety of methods to review and summarize lecture information including the fishbone technique (Figure 2a and 2b). Students also had an opportunity to use a simple concept map to summarize a clinical case (Figure 2c and 2d). These had been modeled by the instructor for one of the previous

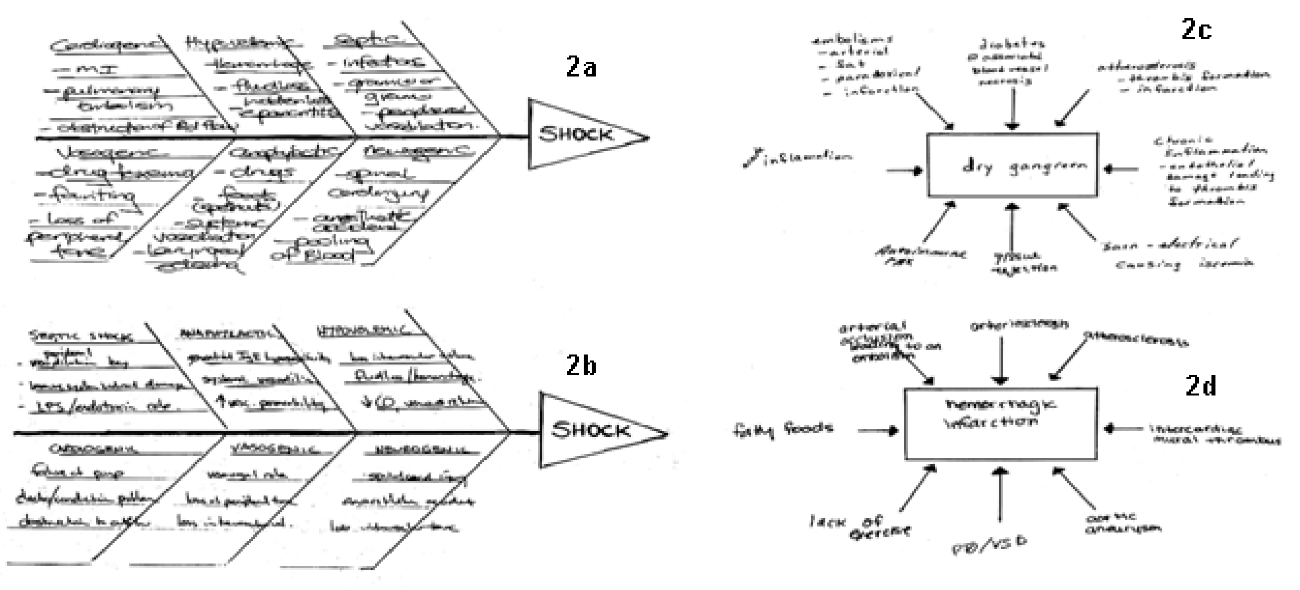


Figure 2. Summarizing Techniques.
Students were asked to evaluate a brief case of an 83-year-old schizophrenic woman who was brought to the emergency department by her neighbors because her leg was blue-black from the knee down. The fishbone technique was used to advantage to clarify and summarize the complex concept of shock (2a and 2b). A simple concept map, demonstrated the key features needed to understand the case (2c and 2d).

topics and for the next lecture the students were asked to participate in developing one of their own working in a small group within the confines of the classroom. In most cases, the students handed in their work as they left the class for the day as a record of their participation in active learning and towards their final grade. Throughout the course, the instructor continued to use PowerPoint presentations and distribute handouts based on these presentations. In this way, some of the traditional lecture structure remained the same as more active learning strategies were added.

Student work was collected over the course of the term. The entire class (88 students) participated in the classroom activities with varying degrees of enthusiasm. There appeared to be engagement in the activities and a good deal of productive "buzz" in the lecture theatre during the activities. The instructor and coach continued to modify the activities throughout the course based on the perceived reactions of the students to the activities. The objectives were not for the students to become proficient with the different activities and they were not graded on the quality of the assignments they handed in at the end of class; they were merely awarded a percentage of their grade for handing *something* in. A sampling of the student responses to the activities was often shared with the large group at the beginning of the next class. Students requested to hear how others had responded and sharing these responses seemed to spark enthusiasm.

The instructor had no further teaching responsibilities in this course after the mid-term so students' perceptions of the active learning strategies were gathered through an anonymous questionnaire administered as a component of the mid-term exam; it was worth 2 marks toward the mid-term grade (Table 1). The questionnaire was the last page of the exam and was torn off to preserve the anonymity of the students. The questionnaires were collated and analyzed on a semi-quantitative and qualitative format. The student performance at the midterm was also used as a performance assessment as the question content was predominantly from the material covered by this instructor.

RESULTS

The student performance at the Midterm exam was slightly better in comparison to the previous years; there was no regression of marks in comparison to the previous years (Figure 3). This reassured the instructor's guiding medical philosophy of "Do no harm."

The overall feedback from the students to the midterm questionnaire was generally favorable. Table 2 indicates the responses to the three yes-no questions. In the comment section, the students generally enjoyed the interaction with peers and liked to participate in these classroom activities. Some indicated that they did not perceive that these changes in teaching methodology actually helped them learn more easily. For some students, however, the summarization techniques and the metaphors and analogies were helpful in clarifying concepts and provided tools to review the concepts over the longer term. In that respect, all objectives were met to some extent. Of the total number of 256 responses to the open-ended questions from the students, 170 (67%) were positive about the inclusion of these active learning strategies. Seventy-two responses were negative (28%) while 14 (5%) comments were neutral. The 14 neutral comments were primarily about the time of day the class was offered and observations about the handout package. The negative comments clustered mostly around a concern that activities took away from lecture time (39 of 72-– 54%) without adding significantly to learning or the development of interpersonal skills. The positive comments, however, indicated that interacting with others and engaging in these activities was useful in clarifying the concepts, it was enjoyable, and the class moved more quickly (Table 3).

Table 2. Part C Midterm Evaluation/Reflection: Response to # 7, 8 and 9

	Yes	No	Other
7. I liked to participate	70%	28%	2%
8. I enjoyed the social interaction/integration	88%	10%	2%
9. This teaching methodology helped me to learn easily	47%	52%	1%

DISCUSSION

From the wide variety of strategies that can be used to actively engage students in their own learning, the ones that are chosen depend on the objectives of the course and the needs of the students. Simulations, demonstrations, experiments, debates, role play, small group discussions, creating visual representations and models, problem solving, case studies, research and presentations, and games are all examples of active learning strategies. These strategies are

Table 3. Summary of Qualitative Students' Responses

Categories	Positive	Negative
Impact on learning	Helped (50)	Did not help (13)
"Enjoyment factor"	Enjoyed (60)	Did not enjoy (5)
Group interaction	Positive (54)	Negative (6)
Analogies	Added to learning (26)	Detracted from learning (11)
Use of class time		Not "lecture time " (39)

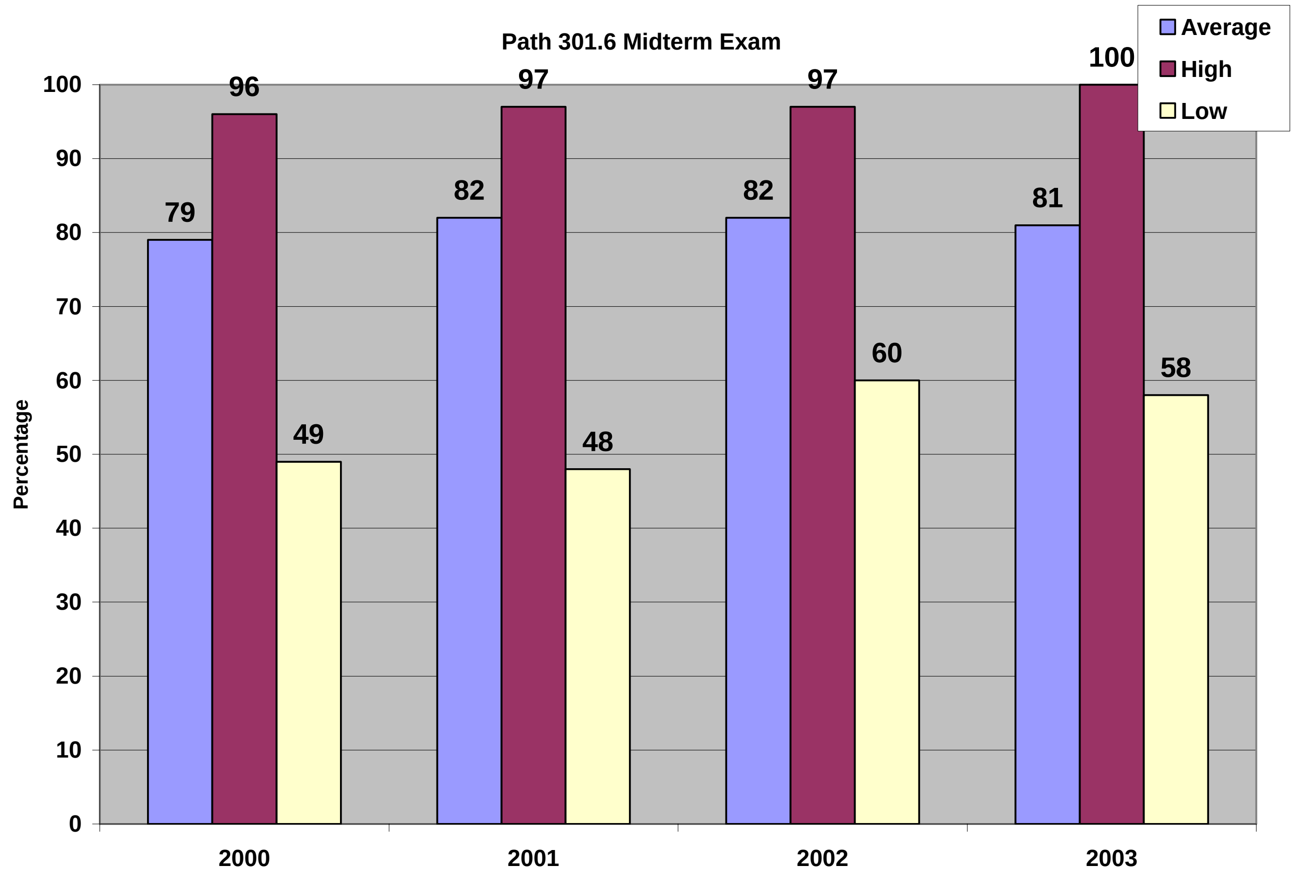


FIGURE 3. Student Performance on Midterm Exam

widely employed in primary and secondary classes and in adult education and workplace training.

Although the feedback from students favored the incorporation of active learning strategies overall we found the negative comments about active learning detracting from lecture time confusing given the endorsement of active learning from the literature. The literature is clear on the benefits of active, student-centered learning over a strictly lecture approach. Lecture is not ineffective but active involvement in the learning process is beneficial to students,[11] it reduces the density in the lecture thereby increasing retention,[12] and addresses a wider range of objectives over and above the transfer of content from instructor to student. Very simply put, "there is a great difference between imagining that we have done the problem and actually doing it,"[13] active learning provides an opportunity for students to do the problem.

The College of Medicine at the University of Saskatchewan has been educating faculty about the benefits of active learning, and providing support through workshop sessions and personal assistance to instructors to restructure lessons. The course instructor involved in this study has attended all of these workshops. Incorporating new strategies takes effort, flexibility, and faculty-driven initiative to make changes as well as the drive to try and make them work. The overall feedback in this one course of general pathology medical and dental students indicates that the students are not as receptive to the perceived benefits of the inclusion of active learning strategies in their lecture sessions as we thought they might be. The biggest criticism seemed to be reflected in their comments about "wasted time." It may be that longer range objectives do not figure prominently in a somewhat myopic view of students to successfully complete their exams. In this context, it is important to remember that the postmodern student who "despises above all theoretical constructs so vague as to be irrelevant to anyone outside the discipline"[1] is skeptical of authority and visual learners. These students also have "an entirely different set of values, including an absence of inherent respect for authority, a willingness to demand that information be both relevant and entertaining, and above all else a need for all their interactions to be personal, including those that over the ages have remained strictly professional."[1] In short, these students demand that the teacher-student interaction be different and, as part of that, that different instructional approaches be used. Awareness and recognition of this led to the incorporation of active learning strategies in the fond hope that it might appeal to their varied ways of learning. Although the students enjoyed the interaction, some of the students did not see a benefit to their learning and felt that it detracted from traditional lecture time. Students, though alerted and prepared for these "new" activities, still felt uncomfortable exploring and breaking new ground as opposed to the traditional lecture format which with they are both familiar and extremely comfortable. The perception of "wasted time" and lack of recognition of learning in group work need to be addressed as these students have to be comfortable in a "team" approach for their future professional careers. This is not atypical; students are resistant to active learning techniques because "they have not been trained to cooperate in the academic environment."[14] Students may feel that the lecture method is easier for them because they can remain passive in a way they are comfortable with and to which they are accustomed.

This exploration has also raised the question of the organizational climate toward wider instructional methodologies. If some instructors are concerned that they do not have enough time to "cover the content"[15] then any time spent not directly transmitting content from instructor to student may be interpreted as a waste of time, and not recognized as "teaching." The appearance of anything other than a lecture being not serious teaching[14] hinders the involvement of students in their own learning. Medical education has an historical and traditional texture that is familiar and comfortable to both faculty and students. In addition to taking a great deal of effort on the part of the instructor, changing this seems to raise the level of anxiety among students who think that they may not be getting what they need to "pass the exam." It is the final exam which seems to drive the students' involvement with instruction,[16] and this raises the question of the learning styles and study habits of this particular group of students which may be different from an average group of undergraduate university students. Such knowledge of learning styles and study habits may help to choose active learning strategies that enhance the learning experience for the students while addressing content and process objectives. This will be the subject of future study.

CONCLUSION

In summary, active learning strategies can be incorporated in the delivery of pathology education as a renovation of the traditional undergraduate medical curriculum. The adoption of such strategies does need the flexibility, time, and effort of both the instructor and the participating students, and is an embrace of the spirit of exploration. Some students were somewhat resistant to change and some students seemed to equate "teaching" with "lecture" and any other modes were interpreted as non-teaching activities. Some students tolerated the activities rather than being actively engaged in the same. The perceived immediate benefits need to be observed in relation to the extra effort required to teach in this way for the current climate of medical students in our school in addition to designing studies to examine the potential long term benefits of including these strategies in undergraduate medical education. The long-term effectiveness of incorporating metaphor and analogy, and summarization techniques such as the fishbone with interpersonal skill development as objectives along with content objectives, however, may only become apparent when these students function as doctors in team-oriented, patient-centered clinical practices.

REFERENCES

1. Fowler, G. Postmodernism: this changes everything! *The journal of student centered learning.* 2003; 1(2): 87-95.
2. Smith, P. Curricular transformation: why we need it, how to support it. *Change.* 2004; Jan/Feb: 28-35.
3. Smith, P. Curricular transformation: why we need it, how to support it. *Change.* 2004; Jan/Feb: 28-35.
4. Nelson, C. Student diversity requires different approaches to college teaching, even in math and science. *American behavioral scientist.* 1996; 40 (2): 165-175.
5. Wlodkowski, R. Fostering motivation in professional development programs. *New directions for adult and continuing education.* 2003; Summer(98): 39-47.
6. Jamshidi, H. and Cook, D. Some thoughts on medical education in the twenty first century. *Medical Teacher.* 2003; 25: 229-237.
7. Salas, E., Burke, C., Bowers, C., and Wilson, K. Team training in the skies: Does crew resource management training work? *Human Factors*. 2001; 43: 641-674.
8. Leipzig, R., Hyer, K., Ek, K., Wallenstein, S., Vezina M., Fairchild, S., Cassel, C., and Howe, J. Attitudes toward working on interdisciplinary healthcare teams: a comparison by discipline. *Journal of the American Geriatrics Society*. 2002; 50: 1141-1148.
9. Wright, W. and O'Neil, M. Perspectives on improving teaching in Canadian universities. *Canadian journal of higher education.* 1994; XXIV(3): 26-57.
10. Kemmis, S. Action research. In J. Keeves & G. Lakomski (EDS.), *Issues in educational research.* 150-160. New York: Pergamon. 1999.
11. Terenzini, E. and Pascarella, P. Living with myths: Undergraduate education in America. *Change*. 1994; Jan/Feb: 28-32.
12. Russell, I., Hendricson, W., and Herbert, R. Effects of lecturing information density on medical student achievement. *Journal of Medical Education.* 1984; 57: 881-889.
13. Zull, J. *The art of changing the brain: Enriching teaching by exploring the biology of learning*. Stylus Publishing: Sterling, VA. 2002.
14. Panitz, T. Why more teachers do not use student centered learning techniques and policies needed to encourage positive changes. *The journal of student centered learning.* 2003; 1(2): 55-60.
15. Nelson, C. What is the most difficult step we must take to become great teachers? *The National Teaching and Learning Forum*. 2001; 10(4): 10-11.
16. Biggs, J. *Teaching for quality learning at university: What the student does?* Buckingham, UK: Society for Research into Higher Education and Open University Press, 1999.

Distributed Immersive Virtual Reality Simulation Development for Medical Education

Dale C. Alverson, M.D.[1], Stanley M. Saiki Jr, M.D.[4, 8], Thomas P. Caudell, Ph.D.[2], Kenneth Summers, Ph.D.[2], Panaiotis, Ph.D.[2], Andrei Sherstyuk, Ph.D.[4], David Nickles, M.S.[4], James Holten, III[2], Timothy E. Goldsmith, Ph.D.[3], Susan M. Stevens, M.S.[3], Kathleen Kihmm[4], Stewart Mennin, Ph.D.[1], Summers Kalishman, Ph.D.[1], Jan Mines, M.A.[1], Lisa Serna[1], Steven Mitchell, M.D.[1], Marlene Lindberg Ph.D.[4], Joshua Jacobs, M.D.[4], Curtis Nakatsu, M.D.[4], Scott Lozanoff, Ph.D.[4], Diane S. Wax, M.P.A., M.B.A.[1], Linda Saland, Ph.D.[1], Jeffrey Norenberg, PharmD.[5], George Shuster, DNSc.[6], Marcus Keep, M.D.[1], Rex Baker, M.D.[1], Holly S. Buchanan, Ed.D.[1], Randall Stewart, M.D.[1], Mark Bowyer, M.D.[7], Alan Liu, Ph.D.[7], Gilbert Muniz, Ph.D.[7], Robert Coulter, M.A.,[1] Christina Maris[1], David Wilks, M.D.[1]

[1]School of Medicine, [2]School of Engineering, [3]Department of Psychology, [5]College of Pharmacy, and [6]College of Nursing
[1]University of New Mexico, Albuquerque, New Mexico 87131 U.S.A.
[4]John A. Burns School of Medicine University of Hawaii, Honolulu, Hawaii 96822 U.S.A.
[7]National Capital Area Simulation Center, Uniformed Services University of the Health Sciences, Silver Springs, Maryland 20910 U.S.A.
[8]Pacific Telehealth and Technology Hui, Tripler Army Medical Center, Honolulu, Hawaii 96859 U.S.A.

Phone: (+)1-505-272-8633 Fax: (+)1-505-272-0800 Email: dalverson@salud.unm.edu

ABSTRACT

Training professionals for real-world application of required knowledge and skills and assessing their competence are major challenges. Simulations are being used in education and training to enhance understanding, improve performance, and assess competence. Validated virtual reality (VR) simulations provide a means of making experiential learning reproducible and reusable. Advanced communication networks, such as Internet2 Access Grid, allow dissemination of these simulations and collaborative learning independent of distance. The prior experiences of our three universities led to an interdisciplinary collaboration to further develop and evaluate an integrated, fully immersive, interactive VR based system. This environment employs simulations that are visually three-dimensional and are driven dynamically by a rules-based artificial intelligence engine within Flatland, a virtual environments development software tool, and associated commodity hardware. Studies include usability and validation, deployment for distributed testing over Internet2, and evaluation of impact on training and performance using concept mapping and knowledge structure methods. Subject matter experts found face and content validity in our closed head injury simulation. Seven pairs of medical students participated collaboratively in problem solving and managing of the simulated patient in VR. Students stated that opportunities to make mistakes and repeat actions in VR were extremely helpful in learning specific principles and they felt more engaged than in standard text-based scenarios. 48 students participated in knowledge structure experiments pre and post simulation experiences. Knowledge structure relatedness ratings were significantly improved in those students with lower pre-VR relatedness ratings indicating a potential value of VR simulation in learning. This research cuts across the integration of computing, networking, human-computer interfaces, learning, and knowledge acquisition. VR creates a safe environment to make mistakes and could allow rapid deployment for just-in-time training or performance assessment.

INTRODUCTION

The vast amount of existing and emerging new knowledge in the health related sciences create new challenges in medical education. Furthermore, there are several medical science concepts that are difficult for learners to comprehend and educators to teach.[1] Developing methods to determine adequate acquisition, retention and competence in the application of those concepts and knowledge, as well as attainment of appropriate clinical skills, continues to be a major critical endeavor in medicine[2] as efforts to decrease medical errors and improve quality of care have reached high levels of public interest.[3, 4]

Simulations have been used as a method to enhance learning, training and assessment of competence. In a detailed analysis of the literature and review of military simulation efforts, Champion and Higgins[5] concluded that simulation is an effective and cost efficient approach to training military personnel, enhancing knowledge transfer, and improving performance. For example, they reported that flight simulators have been shown to be effective for training and improving subsequent performance and that simulation, if designed and integrated appropriately, could be applied effectively in training combat medics and physicians. Similar conclusions were reported by Satava and Jones[6] regarding the potential value of using virtual reality to assess competence. Ziv, et. al., [7] also make a compelling argument of the need to develop further simulation-based medical education as an ethical imperative to ensure optimal treatment, patient safety and well being. They argue an ethical analysis should include four themes; 1) best standards of care and training, 2) error management and patient safety, 3) patient autonomy, and 4) social justice and resource allocation. In addition, learning from mistakes in a simulation offers opportunities to improve understanding, gain confidence, transfer knowledge and achieve appropriate performance.[8]

We report on our ongoing experience in developing, testing and evaluating the application of virtual reality simulation for medical education and training, both on-site and distributed over distance.

MATERIALS AND METHODS

These studies were developed and performed from September 2002 through May 2004. Institutional human research review boards at both University of New Mexico (UNM) and University of Hawaii (UH) approved this project for the user and student experiments. Signed informed consent was obtained from all participating subjects. The National Capital Area Simulation Center at Uniformed Services University of the Health Sciences and the Pacific Telehealth and Technology Hui at Tripler Army Medical Center and Veterans Administration, in conjunction with UH, have been participating in the ongoing planning, development and implementation of this project.

The Virtual Environment

An immersive three-dimensional (3D) environment allowed real-time exploration, examination, and manipulation of 3D objects and images.[9] A problem-based learning (PBL)[10-12] case designed to demonstrate an evolving epidural hematoma in a patient (Mr. Toma) post car crash was used for these pilot studies. The interactive patient simulation allowed students to dynamically determine the outcome of the case scenario**.** The artificial intelligence (AI) engine was coupled to the virtual environment and represented by a virtual patient that manifested the signs and symptoms of the medical scenario. Students were fully immersed and represented within the virtual environment or observed by others from outside the virtual world. Immersed students wore a head-mounted display with trackers, allowing them a sense of presence and interaction within the virtual environment. Team members within the virtual environment were able to see each other as full human figures (avatars) and interact as if they were physically present, even when separated by significant distances. Students could examine the virtual patient, independently controlling their viewpoint and motion within the virtual world. The ratio between real time and virtual time could be varied to allow slower or faster progress of events. The immersed users worked individually or within a group to gather information and initiate interventions. When used within a PBL type tutorial, the students and tutor can discuss the case as it unfolded, pausing the scenario as appropriate, to discuss their observations, hypothesize, and generate learning issues (Figure 1). Students can also use these simulations in learning pairs or individually without a tutor.

Flatland served as the software infrastructure.[13]It is an open source visualization/virtual reality application development environment, created at the University of New Mexico. Flatland allows software authors to construct, and users to interact with, arbitrarily complex graphical and aural representations of data and systems. It is written in C/C++

Figure 1. When used within a Problem-Based Learning (PBL) type tutorial, the students and tutor discuss the case as it unfolds, pausing the scenario as appropriate, to discuss their observations, hypothesize, and generate learning issues

and uses the standard OpenGL graphics language to produce all graphics. In addition, Flatland uses the standard libraries for window, mouse, joystick, and keyboard management. It is object oriented, multi-threaded and uses dynamically loaded libraries to build user applications in the virtual environment (VE). The end result is a virtual reality immersive environment with sight and sound, in which the operator using joy wands and virtual controls can interact with computer-generated learning scenarios that respond logically to user interaction. Virtual patients can be simulated in any of several circumstances, with any imaginable disease or injury (Figure 2).

At the core of Flatland is an open, custom, transformation graph data structure that maintains and potentially animates the geometric relationships between the objects contained in the graph. Graph objects contain all of the information necessary to draw, sound, touch, and control the entity represented by the object. By being intrinsically multi-threaded, Flatland allows the system to make use of computer systems with multiprocessors and shared memory. The main thread may spawn multiple threads to service graphics, sound, tracking and Internet-based collaboration. An application in the context of Flatland is a relatively self-contained collection of objects, functions and data that can be dynamically loaded (and unloaded) into the graph of an environment during execution. An application is responsible for creating and attaching its objects to the graph, and for supplying all object functionality. It is added to Flatland through the use of a configuration file. This structured file is read and parsed when Flatland starts, and contains the name and location of the libraries that have been created for the application, as well as a formal list of parameters and an arbitrary set of arguments for the application.

In Flatland, graphics and sound can be treated symmetrically. Sound interfaces are modeled on the OpenGL interface used for the graphics. All sound is emitted in Flatland from point sources in the 3D space. The author specifies the location of the sounds in the same model coordinate system used for the graphics.

Flatland is designed to make use of any position-tracking technology. A tracker is a multiple degree of freedom measurement device that can, in real time, monitor the position and/or orientation of multiple receiver devices in space, relative to a transmitter device. In the standard Flatland configuration, trackers are used to locate hand held wands and to track the position of the user's head. Head position and orientation are needed in cases that involve the use of head mounted displays or stereo shutter glasses (Figure 3).

User interaction is a central component of Flatland, and as such, each object is controllable in arbitrary ways defined by the designer. Currently there are four possible methods for the control of objects: 1) Pop up menus in the main viewer window, 2) the keyboard, 3) 2D control panels either in the environment or separate windows, and 4) external systems or simulations. In the future there will also be available 3D menus and controls in the virtual environment and voice recognition.

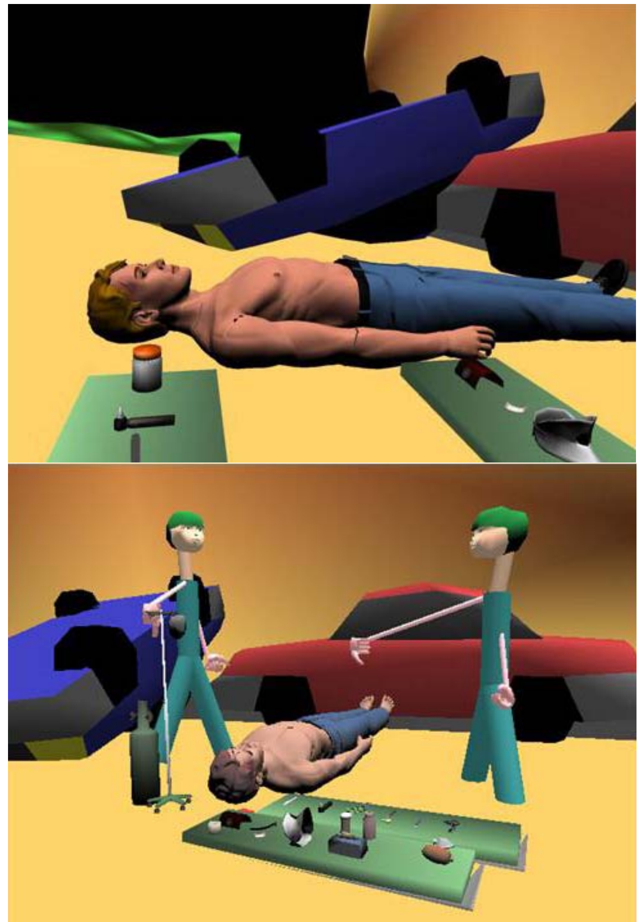


Figure 2. The simulation artificial intelligence (AI) engine dynamically governs changes in physiology, physical findings, movement and events, as well as responses to the user

The immersed user or avatar interacts with the virtual patient using a joy wand equipped with a six degree of freedom tracking system, buttons, and a trigger. The wand's representation in the environment is a virtual human hand. The user may pick up and place objects by moving the virtual hand and pulling the wand's trigger. The user avatars can also interact simultaneously as a team visually and verbally, point to point or multi-point using multi-casting over the Access Grid™ (Figure 4).[14, 15]

Artificial Intelligence (AI)

The artificial intelligence is a forward chaining IF-THEN rule based system that specifies the behavior of objects in the VR world. The rules governing the physiology of the avatar were obtained from subject matter experts. The rules are coded in a C computer language format as logical antecedents and consequences. The AI loops over the rulebase, applying each rule's antecedents to the current state of the system, including time, and testing for logical

Figure 3. The student user virtual reality work station

matches. Matching rules are "fired," modifying the next state of the system. Time is a special state of the system that is not directly modified by the AI, but whose rate is controlled by an adjustable clock. Since the rate of inference within the AI is controlled by this clock, the user (or student) is able to speed up, slow down, or stop the action controlled by the AI. This allows users to learn from their mistakes by repeating a scenario.

Access Grid™

The Access Grid™ (AG) is a combination of multimedia resources used to support group-to-group interactions and communication via high-speed IP/TCP networking over the Web.[15]The AG allows users to share interactive experiences at multiple sites. Developed by the National Computational Science Alliance (NCSA) and led through efforts at Argonne National Laboratory, it is open source and is currently used in over 150 institutions worldwide (Figure 5).

The independent camera viewpoint application, called the Access Grid Remote Camera, captures images from the Flatland environment and transmits them over the AG for viewing at remote sites. This camera is used to capture the third-person independent view of the activities and objects within Flatland. The AG Camera can move around within

Figure 4. Students can interact and work together simultaneously in the fully immersive virtual environment independent of distance. Shown here is a student in New Mexico working in the virtual simulation with a student in Hawaii.

Flatland to any position. Multiple cameras may be launched simultaneously and separately moved for multi-view transmission into the AG. In addition, multiple participants and their avatars can be represented and tracked within the virtual environment allowing group interaction independent of distance, sharing tasks and passing off of objects. This capability permits real-time virtual team collaboration when those participants are in separate locations.[14]

Evaluation Methods

Evaluation consisted of several different initiatives over the past two years; 1) usability surveys by a variety of volunteers, 2) face and content validity surveys by selected subject matter experts, 3) knowledge acquisition experiments using medical students randomly selected to participate in one of four PBL-type learning formats for comparative analysis and determination of concurrent validity with a standard text-based clinical case, 4) knowledge structure relatedness non-PBL experiments using individual medical students pre and post a VR simulation experience.

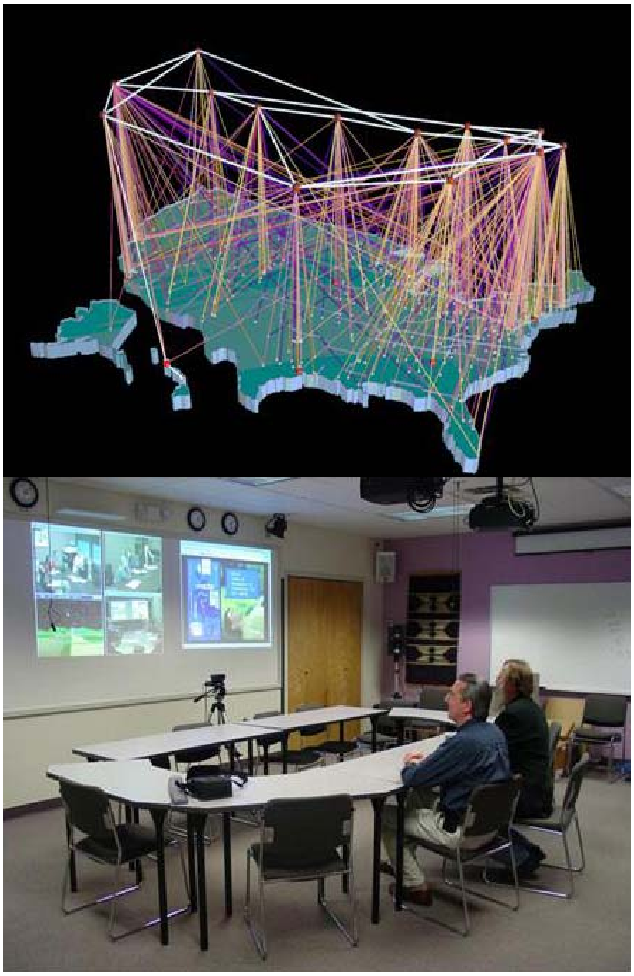


Figure 5. The Access Grid™ is an IP/TCP open source platform which supports multicasting and allows many participants to interact and multiple applications to run simultaneously

1) Usability
Usability analysis was accomplished applying a questionnaire during the virtual reality simulation experience. Demographic information sought included age, gender, health profession, area of health graduate study, experience with virtual reality, gaming, internet, and computers. There were 35 questions related to identification of objects, use of objects, comfort and VR instruction adequacy. 34 questions/statements used a one to four Lickert scale with four demonstrating highest agreement to the statement. One question asked about the number of requests for assistance.

2) Face and Content Validation
Face and content validity were determined by four subject matter experts' review of the VR simulation followed by responses to a questionnaire at the time of the review. Those subject matter experts were all medical doctors selected randomly with some experience with simulation and virtual reality, representing the fields of internal medicine, neurosurgery, neonatology/intensive care, and psychiatry.

The questionnaire was designed to obtain expert group consensus in the determination of subject groups to be used in the evaluation of learning and the educational value of the simulation. In designing the survey, consensus on the questions to present was derived from participants from previous experiments with the consideration of lessons learned from previous phases. The questionnaire itself offered an outline of the key lessons learned for the experts to consider when filling out the questions. This included issues and concerns regarding sample size, time issues and the need to obtain prior insight on the current level of competence. The questionnaire was administered via a webpage with a database backend for ease of collection and compiling of data.

3) Knowledge Acquisition and Concurrent Validation
In another set of experiments using a PBL-type format, comparative knowledge acquisition studies were done using four comparison study groups consisting of fifteen pairs of fourth year medical students and a standardized case; text-based only or VR enhanced with or without distance using the Access Grid. Knowledge acquisition by the students was determined using pre and post testing at the time of the experiments. The thirty multiple choice questions in the tests were developed by subject matter experts as they related to the concepts based on the learning goals and objectives that were integrated into the case scenario equally for all four groups. Multiple choice items were validated by an Emergency Medicine physician and a family practitioner. Items were tested for a ceiling effect using the method described by Meier (2004).[16]The students were given 30 minutes to complete each test.

In order to judge short term knowledge retention, a post-post test was administered to all students approximately two weeks after their session. This test consisted of four multiple choice questions that asked the students to explain in a short written response the reason why each of the possible choices was correct or incorrect. The four questions were selected from the pre-post test. Responses classified as incorrect were assigned zero points, partially correct one point, and correct two points. All responses were graded by two faculty members blinded to the type of group in which each student participated.

4) Knowledge Structure
In a separate set of non-PBL experiments, relatedness ratings were performed using individual students. Student learning was evaluated by comparing students' knowledge structures to experts both before and after VR training. Five subject matter experts were asked to identify 25 central concepts associated with the case and the learning goals and objectives. Examples of the concepts were anisocoria, brainstem herniation and Cushing's Triad. These same experts then rated the relatedness of concept pairs and Pathfinder[17] was used to derive an expert knowledge network from the averaged ratings. The 25 concepts were represented as nodes in the network and the links between nodes reflected the semantic relatedness of the concepts.

Table 1. Post Test Scores

	VR	Paper	Total
Access Grid	68.8 (5.4)	48.4 (4.4)	57.1 (4.3)
Non-distributed	57.8 (6.7)	73.4 (2.8)	65.6 (4.0)
Total	62.5 (4.5)	60.9 (4.1)	61.7 (3.0)

Scores are based on percentage correct out of 8 multiple choice questions; Mean (SE). Multiple analysis of variance with VR and Access Grid as the independent variables indicates a significant interaction between VR and Access Grid ($F = 5.22$; $df = 3, 26$; $p = 0.006$).

This expert knowledge network served as a referent against which students' knowledge networks were evaluated. Forty-eight medical students (28 males, 20 females) from the University of New Mexico and the University of Hawaii voluntarily participated in the study. They were compensated $100 (US) for their efforts. Students ranged from their first to fourth year in medical school, with a mean of 2.96 years. Within the virtual environment, students diagnosed and treated a patient who was experiencing a hematoma as a result of a car crash. The study phase lasted approximately 1.5 hours. Both prior to and after training, participants rated the semantic relatedness of a subset of the pairs of 25 core hematoma concepts on a five-point Lickert scale. Pathfinder was used to derive pre- and post-training knowledge structures for each student from the relatedness ratings. Each structure network was compared to the previously defined expert network resulting in a similarity index*(*s) that ranged from zero to one.

RESULTS

1) Usability

There were 21-26 respondents to each question on the usability survey. The respondent demographics consisted of 14 female and 12 male and age ranges (years); median age 40 (±12.2, range 19-60). Nurses comprised 11/26 (42%) of the respondents. The majority of the older age groups were in the nurse category. A declared major area of health study was stated by 13/26 respondents; Allied health (2), nursing (5), pharmacy (4), EMS (1), medicine (1). Based on a Lickert scale, prior VR experience was low with 1.15/4 (range 1-2), gaming experience was slightly higher at 1.85/4 (range 1-3) on the Lickert scale, with Internet experience and computer experience significantly higher at 3.54/4 (range 2-4) and 3.77/4 (range 3-4) respectively.

As part of the usability questionnaire evaluation, six pairs of questions rating identification (ID) of objects in VR vs. use of objects in VR were analyzed by applying paired T-test using the mean score of all respondents and, if needed, the mean respondent value for any missing answers. Results of the Paired T test were $t = 4.58$, $p = .0002$, indicating the test subjects found it easier to identify objects in VR as compared to using them in VR. Chi square analysis indicates 66% of respondents found it easier to ID an object than to use the object. In addition, the average score for all identification questions (10) = 3.49/4 (range 3.00-3.77), average score of all use-related questions (18) = 2.79/4 (range 2.05-3.18). Regarding the question on number of times 23 respondents needed to ask for assistance; 0 = 11/23 (48%), 1 = 5/23 22%), 2 = 4/23 (17%), 3 = 2/23 (9%), 4 = 1/23 (4%). 7/23 (30%) needed to ask for assistance more than once.

In the usability studies, because sample size was small, some of the variables were necessarily confounded (e.g. nurse and age groupings). Thus, the interpretation of correlations on these variables must be qualified.

Comfort of the head mounted display was rated by 26 respondents with an average score of 2.54/4, with the following comments from individual respondents; discomfort (4), hard to use with glasses (3), loose fit (3), heavy (1). Lack of ill effects of immersion was scored 2.88/4 with the following comments from individual respondents; nausea (3), mild dizziness (2), motion sickness (1), eye strain (1), disorientation and off-balance (1). Usability studies allowed improvements in user interface, locomotion and navigation.

2) Face and Content Validation

Upon review of the case-based simulation, the four subject matter experts found face and content validity in the content and representations in the simulation based on the learning goals and objectives of the case. Subsequently, after all the experts completed the questionnaire, the data was gathered, organized and posted on a webpage for experts to discuss and review. The results were available for review previous to meeting so that the experts had a chance to review their own answers, as well as the other participants. A general meeting was held to review all the results and obtain a consensus on how to proceed. The questionnaire enabled the experts to individually assemble and record their opinions, ideas, issues and concerns and later view the total results for discussion and conclusions.

3) Knowledge Acquisition

In these experiments, fifteen pairs of medical students in Hawaii and New Mexico participated collaboratively in problem solving and management using a text-based case or a simulated patient in VR on site or independent of distance over the Access Grid. Some students indicated that the "ability to interact with a colleague from a distance is helpful" and that better understanding of the concepts in the case came from "being able to communicate with a colleague". Student reaction provided confirming evidence that distributed learning enables interchange between geographically distant students and allows students from different institutions to interact. VR did create higher performance expectations and some anxiety among VR

Table 2. Gain in Scores from Pre-Test to Post Test

	VR	Pape	Total
Access Grid	29.2 (6.2)	20.3 (5.2)	24.1 (4.0)
Non-distributed	20.3 (4.7)	40.6 (3.1)	30.5 (3.8)
Total	24.1 (3.8)	30.5 (3.9)	27.5 (2.8)

Scores are based on percentage correct out of 8 multiple choice questions; Mean (SE). Multiple analysis of variance with VR and Access Grid as the independent variables indicates a significant interaction between VR and Access Grid (F =4.31; df = 3, 26; p = 0.01).

Table 3. Post Post Test Scores

	VR	Paper	Total
Access Grid	19.8 (9.3) range = 9 - 32	22.4 (5.6) range = 16 - 32	21.2 (7.3)
Non-distributed	24.3 (7.8) range = 14 - 32	21.9 (3.5) range = 17 - 26	23.1 (6.0)
Total	22.4 (8.5)	22.1 (4.4)	22.2 (6.6)

Scores are based on one point for each partially correct explanation and two points for each correct explanation on the 19 essay questions. Average scores for each group and standard deviations (in parentheses) are reported. Multiple analysis of variance with VR and Access Grid as the independent variables: F = 0.50; df = 3, 25; p = 0.68.

users. VR orientation was reported as adequate but students needed time to adapt and practice in order to improve efficiency. Students who used VR stated they felt more engaged than when using text-based cases. Students stated that opportunities to make mistakes and repeat actions in the VR were extremely helpful in learning specific principles. Post-testing performance was similar between the VR and non-VR groups (see Table 1), indicating VR was not a detractor to the learning experience. A 31% average knowledge gain of students participating in non-distributed sessions compared with a 24% average knowledge gain of students in distributed sessions indicated distance was not a barrier to the learning experience (see Table 2). The non-VR non-distributed students had the highest knowledge gain (41%). However, the VR non-distributed and non-VR distributed showed the lowest knowledge gain (20%). Multiple analysis of variance of the gain in scores on the post test using VR and AG as independent variables indicated a significant interaction between those two variables (p = 0.01). Multiple analysis of variance of post-post test scores revealed no significant differences among the 4 groups using VR and AG as independent variables (see Table 3). None of the experimental conditions led to any knowledge loss or misunderstanding of key concepts. The similarity in learning acquisition with or without distance and with or without VR demonstrates concurrent validity with the current PBL case text-based approach.

4) Knowledge structure

In this set of separate experiments there were 48 students who completed the training including both sets of relatedness ratings. There were 28 males and 20 females. Students ranged from first year to fourth year in their programs with the mean number of years equaling 2.96.

Students rated the relatedness of 72 pairs of concepts critical to the case, 36 of which were related as defined by an expert knowledge network, and 36 unrelated. The 36 unrelated pairs were used primarily as foils to balance the related pairs. First each student's raw ratings were correlated with the expert ratings. The average correlation was r = 0.77 for pre training and r = 0.76 for post training, both highly statistically significant (p< 0.001). The high correlation at pre training indicates that the students were knowledgeable of the terms and their relationships even before training. This conclusion is also corroborated by comparing the mean rating of the related pairs (4.25) with the mean rating of the unrelated pairs (1.96) on the set of relatedness ratings before training.

Pathfinder was then used on each of the students' raw ratings to derive a knowledge network. Each student's knowledge network was compared to the expert knowledge network using a method that produces a similarity index (*s*) that varies from zero to one.

The mean similarity scores of all student subjects (N = 48) were *s* = 0.70 before training and *s* = 0.72 after training. A matched t-test on these differences resulted in t = 1.172, p= 0.247. Although the difference did not reach statistical significant, it was trending toward statistical significance (see Table 4).

The pre/post difference may have failed to reach significance because of a ceiling effect; students were already performing at a high level before training. To assess this, a cutoff value was used *s* = .80 to select the subset of students who had similarity to expert scores below this level on the pretest knowledge structures. This resulted in selecting a subset of 36 out of the 48 students. A matched pairs t-test for these 36 students was performed on the difference between the similarity to expert scores before and after training and found t = 2.577, p = .014; a highly statistically significant difference (see Table 4).

Table 4. Pre and Post Knowledge Structure Similarity Scores

	Pre Training	Post Training	paired t-test
N^1=48	0.70 (0.097)	0.72 (0.098)	t = 1.172, p = 0.247
N^2=36	0.66 (0.077)	0.70 (0.096)	t = 2.577, p = 0.014

The mean similarity scores comparing students' to experts' knowledge structure relatedness pre and post virtual reality training. N^1 are the similarity scores of all student participants. N^2 are the sub-set of students with a similarity score of < 0.80 pre-training. Mean (SE)

DISCUSSION

Although the smaller sample size and resulting confounding variables in the usability analysis prevented sub-sample analysis, the group as a whole rated identification of objects in VR significantly higher than use of those objects in VR (paired T test). This may indicate the graphics of VR objects are satisfactory but manipulation of those objects is more difficult and deserves review and improvement or the need for better training to competence in using those tools. In the future, this usability component of our studies would be better designed by increasing the sample size of participants to reflect the potential heterogeneity of the user groups or applying prospective controlled selection criteria to insure a desired balanced mix of potential users.

Although there were no significant overall differences in knowledge acquisition among the different student groups, the quality of the VR or distance learning experience equaled that of the traditional PBL case and there was no knowledge loss. These findings indicate VR or distance did no harm in the learning experiences related to this case, demonstrates concurrent validity with the traditional PBL format, and offers evidence that these methods can be used on-site and in a distributed manner. The participant's ability to act in an environment experimentally, and not just observe it, is a critical feature that simulation provides. According to Winn,[18] the theoretical assumption of learning from simulation is that students can construct understanding for themselves by interacting with information and materials—an orientation to learning that has acquired the name "constructivism."[19] Winn makes a distinction between simulation and reification. The purpose of simulation is to represent real-world objects in as accurate a way as possible. Reification "is the process whereby phenomena that cannot be directly perceived and experienced in the real world are given qualities of concrete objects that can be perceived and interacted within a virtual learning environment."[20] Currently we are applying the reification concept to development of a renal and nephron model with which the learner can interact in VR in order to enhance understanding of a variety of renal physiologic concepts, such as the counter-current concentration mechanism, as well as pharmacologic or pathophysiologic effects on the reified model.

Of central importance to our proposed work is the ability to assess how well someone has learned a complex, conceptually demanding area. Our hypothesis that simulation is better than conventional learning environments needs to be evaluated with psychometrically sound assessments. One accepted method is the use of knowledge structure. Over the past decades, an impressive literature has accumulated showing that the structural properties of domain knowledge are closely related to domain competence.[21] How someone has the central concepts of an area organized in memory relates to his or her level of knowledge. Experts share a particular structural organization of concepts, and as a consequence, are more likely to see certain relevant abstract relationships and connections.[22] Studies have shown that experts in various domains, such as physics and computer programming, organize the central concepts along semantic dimensions, whereas novices focus on surface level characteristics.[23] It is this organization of domain knowledge, we believe, that reflects an individual's degree of conceptual understanding in a domain. Structural approaches to assessing domain knowledge began to appear in the late 1960s and early 1970s.[24, 25]Several investigators reported finding that classroom performance was related to students' structural organization of the central concepts in a course. In our own work, we focused on developing a systematic three-phase methodology for implementing structural assessment (SA): (a) Elicitation: evoking some behavioral index of an individual's organization of domain concepts, (b) Representation: applying statistical techniques to transform the elicited data into a formal representation (e.g., network) that captures the important structural properties of the knowledge, (c) Evaluation: quantifying the level of expertise that is reflected in a derived representation.

The elicitation phase comprises three steps: (1) defining core concepts in the domain by rank-ordering experts' ratings of a list of domain concepts drawn from textbooks and expert input; (2) defining the expert structure based on experts' ratings of all pair wise combinations of concepts; and (3) eliciting proximity data by presenting participants with a target concept from the set of most related pairs in the expert structure accompanied by three choices (one of which is the most related pair item). And finally, having them choose the concept they believe is most related. The viability of this elicitation procedure rests on the assumption that relatedness ratings on pairs of concepts are a valid and reliable measure of individuals' semantic structure. There exists a long history of research and theory going back to James[26] and continuing with the work of Shepard[27] and Tversky[28] that supports this approach.

Representation entails finding a method that converts a proximity matrix of raw relatedness ratings into a form that best elucidates the underlying structure of the relations. The resulting representation should: (a) capture the structural relations among concepts; (b) be easy to comprehend; (c) capture all relevant (e.g., predictive) latent structure; and (d) be data-driven. Several different scaling algorithms have been evaluated—including multidimensional scaling,[29] hierarchical clustering,[30] and untransformed proximity data—and it was found that the Pathfinder[17] algorithm best met the above criteria.[31, 32] Pathfinder generates a connected graph that depicts local concept relationships, which according to Latour,[33]provide the most compact and powerful way of representing data. Most importantly, Pathfinder was the most predictive representation of classroom performance.

Finally, a participant's knowledge structure must be evaluated in terms of the level of competence or sophistication it represents. Two methods were used for accomplishing this. A referent-based evaluation compares a student's Pathfinder network to an expert Pathfinder network, resulting in an index of similarity between 0 and 1.[34]Evaluating a family of similarity indices, indicated that similarity based on the commonality of directly linked concepts provided the best predictor of student performance.[31] This measure of structural similarity is referred to as SIM. A referent-free method of evaluating an individual's knowledge structure was also developed. This method is called "coherence." Coherence measures (0-1 scale) the internal consistency of a set of ratings by examining the extent to which sets of ratings satisfy a generalized triangle inequality law. It has been found that coherence increases with levels of domain expertise.[35]

Using these approaches in the knowledge structure experiments of our studies, students knew the central concepts and their relations for the hematoma case fairly well before training. The data are fairly convincing in support that a ceiling effect was operating in the knowledge structure experiments. We report that the correlation between students' and expert ratings were r=.77 (highly significant) even before any training and that there was a large difference in the mean ratings of the related concept pairs (4.25) and unrelated concept pairs (1.96) again before any training took place. These two findings strongly suggest that students were highly knowledgeable of the concepts and their relations to one another before training. By selecting a subset of students who scored below s=.80 on the pretest and then finding that with these students selected only on the basis of how much knowledge they had before training, a significant increase in similarity to expert knowledge structure after training argues for a ceiling effect in the larger group of students. By examining those students (36/48) who were lower in their knowledge of the concepts before training, we find that their knowledge structures after training are in fact closer to the expert knowledge network than before training, a statistically significant change in that sub-set. There is a modest but statistically significant improvement in students' understanding as a function of the training experience. Two possibilities include the VR training itself and the ancillary material provided. Designing experiments by selecting cases with or without ancillary materials and students with lower levels of correlation with expert knowledge structure may assist in evaluating the impact of the simulation experience on learning. There remains a need for more validation, training to competence in using the VR tools, evaluation of learning impact, knowledge transfer and effects on performance.

Currently, enhancements of simulations with integration of sound and haptics into the VR environment are being explored. The haptics function within an object contains all of the calls or code to produce force or tactile sensations. Without haptics, a user who reaches out to touch a virtual reality object discovers his hand will move through the object, which can be disconcerting. With haptics, the user experiences force feedback. The result is the sensation of actual touch. Currently, only one haptic device is supported in Flatland, and that is called the Phantom™. We are also beginning to integrate sound into the virtual environment to enhance the sense of presence and reality in the virtual experience. Examples of sound integration include the ability for auscultation with the virtual stethoscope to hear breath and bowel sounds, audible responses of the virtual patient to stimulus or pain, sound elicited by the use of certain virtual tools, and ambient noises. Based on our usability studies, we will be remodeling some of the interactive, locomotion and navigation metaphors and tools used within the Flatland virtual environment in order to further improve the user interface, as well as optimize the actual learning or training experience. In conjunction with the Uniformed Services University, we are also porting Flatland to a Windows environment in order to increase the potential user base and compatibility with other systems.

CONCLUSIONS

This research cuts across the integration of computing, networking, human-computer interfaces, learning, and knowledge acquisition. VR creates a safe environment to make mistakes and could allow rapid deployment for just-in-time training or performance assessment.[36-39]These experiments have demonstrated virtual collaboration within VR is possible with multiple participants independent of distance. Students accept use of VR for education and training. Participants stated they felt more engaged in VR. Students also felt they learned best from their mistakes in VR. In comparative experiments, post-testing performance was similar between VR and non-VR Groups, as well as distributed and non-distributed groups, indicating VR or distance distribution "does no harm" and demonstrating concurrent validity with standard text-based problem-based learning (PBL) case methods.

Perhaps most significant was the evidence of improvement in knowledge structure after the virtual reality simulation experience in a select group of learners with initial lower levels of knowledge structure correlation with that of experts. Knowledge structure relatedness ratings were significantly improved in those students with lower pre-VR relatedness ratings which indicate the potential value of simulation in learning, particularly in those students with lower levels of knowledge structure as related to the concepts being learned. In general, the results suggest that the method used for eliciting, representing and evaluating knowledge structure offers a sensitive, objective and valid means for determining learning in virtual environments. More research is indicated using controlled studies to determine more specifically what aspects of the learning event produced the changes in knowledge.

The initial research and development of our virtual reality simulation required significant time and resources through an extensive iterative process requiring ongoing evaluation and improvements. Although our studies were not designed to evaluate cost-benefit, we anticipate that with continued experience, production time and cost should diminish. In addition, we speculate that by using these simulations for distributed team training travel costs and time would be avoided and consistency in the training scenarios could be better achieved. We now plan to develop more simulations using a knowledge-based design approach that would be validated for learning and training, as well as evaluated for impact on learning and performance. We envision creation of a library of simulations that can be integrated into curricula and training programs, modified to meet specific learning goals and objectives of a variety of learners or trainees. Further, a production algorithm is being developed to allow more rapid creation of simulations on demand. A protocol has been developed for communication between subject matter experts and programmers that allows incorporation of medical knowledge into the VR system rapidly. That includes behavioral, physiological, medical and other content-related features of the simulation. We have developed an effective technical pipeline from 3D authoring software to the VR system. We use Maya™ by Alias for creating shapes, textures and animations. To incorporate 3D art created in Maya into Flatland takes a few minutes and the production cycle iterates quickly, allowing incremental improvements of the look-and-feel of the 3D content, until finally approved by subject matter experts. Similar "Maya-to-game" data transition is being used by the leading computer gaming companies in a time efficient manner.

We anticipate development of more collaborative team learning and training initiatives, independent of distance, allowing participants to be physically separated but virtually together. These simulations also provide opportunities for multidisciplinary education. And, in addition to education, they may be useful for screening or testing applications. These methods can create "Just-in-Time" training potential, performance assessment platforms, and more national and international collaborative opportunities.

REFERENCES

1. Dawson-Saunders, B., Feltovich, P.J., Coulson, R.L., and Steward, D.E. A survey of medical school teachers to identify basic biomedical concepts medical students should understand. *Academic Medicine*. 1990; (65): 7: 448-454.
2. Windish, D.M., Paulman, P.M., Goroll, A.H., and Bass, E.B. Do clerkship directors think medical students are prepared for the clerkship years? *Academic Medicine.* 2004; 79: 56-61.
3. Kohn, L., Corrigan, J.M., and Donaldson, M. To err is human: Building a safer health system. Committee on Quality of Health Care in America. *Institute of Medicine.* Washington, D.C. National Academy Press, 1999.
4. Committee on Quality of Health care in America. Crossing the quality chasm: A new health system for the 21st century. *Institute of Medicine*, Washington, D.C, National Academy Press, 2001.
5. Champion, H.R. and Higgins, G.A. Meta-Analysis and Planning of SIMTRAUMA: Medical Simulation for Combat Trauma Training. *USAMRMC TATRC Report*. 2000; No.00-03.
6. Satava, R.M. and Jones, S.B. The Future is Now: Virtual Reality Technologies. In: *Innovative Simulations for Assessing Professional Competence: from Paper-and-Pencil to Virtual Reality.* Tekian A, McGuire CH, McGaghie WC and Associates (eds) University of Illinois at Chicago, Department of Medical Education. 1999; (12): 179-193 .
7. Ziv, A., Wolpe, P.R., Small, S.D., and Glick S. Simulation-Based Medical Education: An Ethical Imperative. *Academic Medicine*. 2003; 78(8): 783-788.
8. Alverso,n D., Saiki, S.M., Jacobs, J., Saland, L., Keep, M.F., Norenberg, J., Baker, R., Nakatsu, C., Kalishman, S., Lindberg, M., Wax, D., Mowafi, M., Summers, K.L., Holten, J.R, Greenfield, J.A., Aalseth, E., Nickles, D., Sherstyuk, A., Haines, K., and Caudell, T.P. Distributed interactive virtual environments for collaborative experiential learning and training independent of distance over Internet 2. In: *Medicine Meets Virtual Reality 12; Building a Better You: The Next Tools for Medical Education, Diagnosis, and Care, Volume 98. Studies in Health Technology and Informatics*. Westwood, J.D., Haluck, R.S., and Amsterdam, H., Amsterdam, the Netherlands: IOS Press; 2004; 98: 7-12.
9. Jacobs, J., Caudell, T., Wilks, D., Keep, M.F., Mitchell, S., Buchanan, H., Saland, L., Rosenheimer, J., Lozanoff, B.K., Lozanoff, S., Saiki, S., and Alverson, D. Integration of Advanced Technologies to Enhance Problem-Based Learning over Distance: Project TOUCH. *Anatomical Record*. 2003; 270B: 16-22 .
10. Kaufman, A., Mennin, S., Waterman, R., Duban, S., Hansbarger, C., Silverblatt, H., Obenshain, S., Kantrowitz, M., Becker, T., Samet, J., and Wiese, W. The New Mexico experiment: educational innovation and institutional change. *Academic Medicine*. 1989; 64: 285-294.

11. Anderson, A. Conversion to problem-based learning in 15 months. In: *The Challenge of Problem Based Learning*. D. Boud, G. Feletti, St. Martin's Press, NY. 1991; 72-79.
12. Bereiter, C. and Scardamalia, M. Commentary on Part I: Process and product in problem-based learning (PBL) research. In: *Problem-based learning: A research perspective on learning interactions.* D. H. Evensen and C. E. Hmelo. Lawrence Erlbaum Assoc. Publishers, NJ. 2000; 185-195.
13. Caudell, T.P., Summers, K.L., Holten, J., Takeshi, H., Mowafi, M., Jacobs, J., Lozanoff, B.K., Lozanoff, S., Wilks, D., Keep, M.F., Saiki, S., and Alverson, D. A Virtual Patient Simulator for Distributed Collaborative Medical Education. *Anatomical Record.* 2003; 270B: 16-22.
14. Mowafi, M., Summers, K.L., Holten, J., Greenfield, J.A., Sherstyuk, A., Nickles, D., Aalseth, E., Takamiya, W., Saiki, S., Alverson, D., and Caudell, T.P. Distributed interactive virtual environments for collaborative medical education and training: Design and characterization. In: Westwood, J.D., Haluck, R.S., and Amsterdam, H. *Medicine Meets Virtual Reality 12; Building a Better You: The Next Tools for Medical Education, Diagnosis, and Care, Volume 98. Studies in Health Technology and Informatics*. Amsterdam, the Netherlands: IOS Press; 2004: 98: 259-261.
15. Childers, L., Disz, T.L., Hereld, M., Hudso,n R., Judson, I., Olson, R., Papka, M.E., Paris, J., and Stevens, R. Active Spaces on the Grid: The Construction of Advanced Visualization and Interaction Environments. In: *Parallelldatorcentrum Kungl Tekniska Högskolan Seventh Annual Conference (Simulation and Visualization on the Grid), vol. 13, Lecture Notes in Computational Science and Engineering.* B. Engquist, L. Johnsson, M. Hammill, and F. Short. Stockholm, Sweden: Springer-Verlag. 1999; 64-80.
16. Meier, S. Improving Design Sensitivity through Intervention-Sensitive Measures. *American Journal of Evaluation*. 25(3): 321-334.
17. Schvaneveldt, R.W. *Pathfinder Associative Networks: Studies in Knowledge Organization*. Norwood, NJ. Ablex; 1990.
18. Winn, W.D. Current trends in educational technology research: The study of learning environments. *Educational Psychology Review.* 2002; 14(3): 331-351.
19. Duffy, T., Jonassen, D. *Constructivism and the technology of instruction: A conversation*. Hillsdale, NJ: Lawrence Erlbaum Association; 1992.
20. Winn, W.D. A conceptual basis for educational applications of virtual reality. *Human Interface Technology Laboratory Technical Report TR-93-9*. Seattle, WA: Human Interface Technology Laboratory, University of Washington; August, 1993.
21. Glasser, R. On the nature of expertise. In: Klix, F. and Hagendorf, H. *Human Memory and Cognitive Capabilities: Mechanism and Performances.* North Holland: Elsevier Science; 1986.
22. Bransford, J., Brown, A.L., and Cocking, R.R. *How People Learn: Brain, Mind, Experience, and School.* Washington D.C.: National Academy Press; 2000.
23. Chi, M.T.H., Glase,r R., Rees, E. Expertise in Problem Solving. In: Sternberg, R.J. *Advances in Development of Human Intelligence, Vol. 1.* Hillsdale, NJ: Lawrence Erlbaum Assoc; 1982.
24. Geeslin, W.E. and Shavelson, R.J. Comparison of content structure and cognitive structure in high school students learning of probability. *Journal of Research in Mathematics Education*. 1975; 6: 109-120.
25. Shavelson, R.J. and Staton, G.C. Construct validation: Methodology and application to three measures of cognitive structure. *Journal of Educational Measurement*. 1975; 12: 67-85.
26. James, W. *The Principles of Psychology*. Cambridge, MA: Harvard Univ. Press; 1890/1983: 434.
27. Shepard, R.N. Toward a universal law of generalization for psychological science. *Science*. 1987; 237: 1317-1323.
28. Tversky, A. Features of similarity. *Psychological Review*. 1977; 84: 327-352.
29. Kruskal, J.B. Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. *Psychometrika*. 1964; 29: 1-27.
30. Johnson, S.C. Hierarchical clustering schemes. *Psychometrika*. 1967; 32: 241-254.
31. Johnson, P.J, Goldsmith, T.E. and Teague, KW. Structural knowledge assessment: Locus of the predictive advantage in Pathfinder-based structures. *Journal of Educational Psychology*. 1994; 86: 617-626.
32. Johnson, P.J., Goldsmith, T.E., and Teague, K.W. Similarity, structure, and knowledge: A representational approach to assessment. In: Nichols, Chipman and Brennan, eds. *Cognitively Diagnostic Assessment*. Hillsdale, NJ: Lawrence Erlbaum Assoc.; 1995: 221-249.
33. Latour, B. Drawing things together. In: Lynch M and Woolgar S, eds. *Representation in Scientific Practice*. Cambridge, MA: MIT Press; 1990: 19-68.
34. Goldsmith, T. and Davenport, D. Assessing structural similarity of graphs. In: Schvaneveldt R, ed. *Pathfinder Associative Networks: Studies in Knowledge Organization*. Norwood NJ: Ablex Publishing Corporation; 1990.
35. Acton, W.H., Johnson, P.J., and Goldsmith, T.E. Structural knowledge assessment: Comparison of referent structures. *Journal of Educational Psychology.* 1994; 85: 88-96.
36. Kolb, D.A. *Experiential Learning: Experience as the Source of Learning and Development.* Upper Saddle River, NJ: Prentice Hall; 1983.
37. Issenberg, S.B. and McGaghie, W.C. Assessing Knowledge and Skills in the Health Profession: A Continuum of Simulation Fidelity. In: *Innovative Simulations for Assessing Professional Competence: from Paper-and-Pencil to Virtual Reality*, Tekian A, McGuire CH, McGaghie WC and Associates, University of Illinois at Chicago, Department of Medical Education.1999: Chap. 9: 125-146.

38. Issenberg. S.B., McGaghie, W.C., Hart, I.R., Mayer, J.W., Felner, J.M., Petrusa, E.R., Waugh, R.A., Brown, D.D., Safford, R.R., Gessner, I.H., Gordon, D.L. and Ewy, G.A. Simulation Technology for Health Care Professional Skills Training and Assessment. *JAMA*. 1999; 282: 861-866.
39. Issenberg, S.B., McGaghie, W.C., Gordon, D., Symes, S., Petrusa, E.R., Hart, I.R., Harden, R.M. Effectiveness of a Cardiology Review Course for Internal Medicine Residents Using Simulation Technology and Deliberate Practice. *Teaching and Learning in Medicine.* 2002; 14(4): 223-228.

ACKNOWLEDGEMENTS

The project described was supported partially by grant 2 D1B TM 00003-02 from the Office for the Advancement of Telehealth, Health Resources and Services Administration, Department of Health and Human Services. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Health Resources and Services Administration.

Favorable Student Attitudes Towards Pharmacology in a Medical College in Western Nepal

Ravi Pathiyil Shankar, Arun Kumar Dubey, Subish Palaian, Mishra Pranaya, Archana Saha, and Vibhavri Yeshwant Deshpande

Department of Pharmacology
Manipal College of Medical Sciences
P.O. Box 155
Deep Heights
Pokhara, NEPAL

Phone: (+) 00977-61-523600 Fax: (+) 00977-61-522160 Email: ravi_p_shankar001@hotmail.com

ABSTRACT

Traditional pharmacology teaching in medical schools does not adequately prepare the student for rational practice. Recently a number of modifications have been introduced in pharmacology teaching and learning. At the Manipal College of Medical Sciences, Pokhara, Nepal pharmacology is taught in an integrated manner with the other basic science subjects during the first four semesters of the undergraduate medical course. The present study was carried on second and third semester students during the month of March 2004 to obtain information on student attitude towards pharmacology, feedback on the assessment process, suggestions to improve pharmacology teaching and learning, basic demographic information about the respondents and to note the association, if any, of the student attitudes with demographic variables. Student attitude was assessed by noting their degree of agreement with 15 statements using a modified five-point Likert-type scale. The statements were grouped into those dealing with student attitude towards the subject and those concerned with improvements in pharmacology teaching and learning. The mean total, subject and improvement scores were calculated. Differences in the mean scores among different subgroups of respondents were analyzed ($p<0.05$). One hundred and thirty-one students participated in the study and successfully completed the questionnaire; 83 were male. The overall student attitude towards pharmacology was positive. Differences in the mean scores were seen among the different subgroups. Differences were also noted in the mean scores of individual statements among different subgroups of respondents. Deficiencies were noted in the system of assessment, which was felt to mainly test factual knowledge. System based assessment using clinical problems, greater number of hospital visits and more problem-stimulated learning sessions were suggested. Improvements in the teaching-learning process and the system of assessment are required to make pharmacology learning more interesting and effective. The sessions on rational drug use should be continued and strengthened.

INTRODUCTION

Pharmacology is a crucial discipline for medical students who are going to be future doctors. It is important that medical students appreciate pharmacological principles and are able to apply them in the practice of medicine.[1] Traditional pharmacology teaching in medical schools is discipline based and teacher-centered with a heavy emphasis on acquiring factual knowledge about drugs[2] and does not train the student adequately for therapeutics.[3]

In the last two decades a number of educational programs have been developed to improve the teaching and learning of pharmacology and therapeutics.[4,5] The World Health Organization (WHO) Action Programme on Essential Drugs has developed a manual for undergraduate medical students on the principles of rational prescribing.[6] Students are taught about a standard pharmacotherapeutic approach to common disorders resulting in a set of first-choice drugs, called personal or P-drugs. They are also taught how to personalize the set of P-drugs to specific patients.[7]

Students should develop 'transferable skills', which are important, not only in undergraduate medical education but also for continued learning throughout their medical career.[8] The student should be able to solve therapeutic problems, prescribe appropriate drugs for disease conditions and communicate meaningfully with the patients.

Problem-oriented teaching can help students appreciate the relevance of the acquired information for appropriate prescribing.[2] Problem-based learning (PBL) has been gaining ground in medical education.[9] Some medical schools have completely switched over to PBL, whereas others use PBL in conjunction with lecture-based learning (LBL).[10]

At the Manipal College of Medical Sciences (MCOMS), Pokhara, Nepal from August 2003, we started to admit 75 students each semester (months of January and August) for the undergraduate medical course (MBBS). Before that we used to admit a batch of 100 students once a year. The students are taught Pharmacology in an integrated manner with other basic science subjects (Anatomy, Physiology, Biochemistry, Microbiology, Pathology and Community Medicine) during the first four semesters of study. The students are mainly from Nepal, India and Sri Lanka with a few non-resident Indians (NRIs) from other countries. The Nepalese students are selected on the basis of an entrance examination while others are selected on the basis of their high school (twelfth standard) marks and their performance before an interview board constituted by the college.

Pharmacology teaching takes place through didactic lectures and problem-stimulated learning (PSL) sessions. Each semester has three or four lectures per week and students are divided into batches of 18 or 19 for the PSL sessions. Each PSL batch is further subdivided into two groups of nine or ten students each. The students solve problems using the concepts taught in the class and the information resources available in the college library. Students are taught about Essential drugs, the P-drug concept and P-drug selection for specific patients. The revised curriculum of Kathmandu University, to which the college is, affiliated places strong emphasis on self-directed learning.[11] The curriculum emphasizes rational prescribing using the WHO Guide to Good Prescribing as the reference standard. Drug use indicators study, assessment of drug promotional materials and communication skills training using simulated patients are taught to encourage rational prescribing.

The students are assessed in all the seven basic science subjects every 15 days. There are separate sets of questions in each subject to be answered in a time period of 30 minutes. There are exams in each subject at the end of each semester and University exams at the end of the second and fourth semester. In the practical examinations, students are assessed on communication skills, clinical problem solving, prescription writing, analysis of promotional materials and drug use indicators.

Studies on the attitudes of medical students towards the crucial subject of pharmacology and therapeutics are lacking in Western Nepal. Such studies are important to obtain student feedback on teaching and learning and to make appropriate changes in the curricula. The present study was carried out to obtain:

a) student attitude toward the teaching and learning of pharmacology at MCOMS
b) student feedback on the assessment process in pharmacology
c) suggestions to improve the teaching and learning of pharmacology and
d) basic information about the student respondents and note any association of student attitude with demographic and other variables.

MATERIALS AND METHODS

The study was carried out among the second and third semester medical students at MCOMS, Pokhara, Nepal during the month of March 2004. The third semester students were admitted in January 2003 while the second semester students were admitted in August 2003. One hundred third semester and seventy-five second semester students were invited to participate in the study. Eighty-five (85%) third and 46 (61.3%) second semester students successfully completed the study and their responses were taken for analysis.

The students were asked to complete a questionnaire, which consisted of three parts. The first part collected demographic and other relevant information about the student respondents. The sex and nationality of the respondents were noted. Information on whether they had completed a Bachelor's course of study was noted. The profession of the parents and medium of instruction at school was recorded. In South Asia because of the British colonial rule and other factors, there are two media of instruction at school. English medium schools teach different school subjects in English while the vernacular medium schools teach them in local languages. In vernacular medium schools, English is taught as a second or third language. Information was collected on whether mathematics was one of the subjects of study at school (eleventh and twelfth standard levels). Their attitude towards mathematics and chemistry at school was recorded. Information was collected on whether the respondent was a self-financing or a government-selected student. The questionnaire used in the study is shown in the Appendix. The questionnaire was pre-tested in ten respondents and their data was not taken up for further analysis.

The second part of the questionnaire consisted of 15 statements. The respondents had to indicate their degree of agreement with the individual statements using a modified Likert-type scale. The students were asked to score each individual statement using the following key: 1- strongly disagrees with the statement, 2- disagrees, 3- neutral, 4- agrees and 5- strongly agrees with the statement. The students were instructed to use whole numbers only. The statements were grouped together under two main headings: subject and improvement. Statements 1, 2, 3, 5, 9, 10, 12, 13 and 14 dealt with the student attitude towards the subject of pharmacology while statements 4, 6, 7, 8, 11 and 15 measured student agreement with suggestions to improve pharmacology teaching and learning. The mean score for the two subheadings and mean total score for all the statements were calculated for each individual respondent. The overall mean subject, improvement and total scores were calculated from the individual mean subject, improvement and total scores.

Table 1. Mean subject, improvement and total scores according to the sex of the respondents

Sex	Subject score (mean ± SD)	Improvement score (mean ± SD)	Total score (mean ± SD)
Male respondents (n=83)	3.53 ± 0.44	4.09 ± 0.46	3.82 ± 0.29
Female respondents (n=48)	3.46 ± 0.38	3.95 ± 0.45	3.7 ± 0.33
P value	0.329	0.108	0.098

The mean subject, improvement and total scores were calculated for male and female respondents, respondents of different nationalities and graduate and non-graduate respondents. It was also calculated for respondents with doctor fathers and with fathers from other professions, for English and vernacular medium students and for students who did and did not study mathematics at the twelfth standard level. The students were grouped into those whose mothers were housewives and those who were professional working women and those who liked mathematics at school, were neutral to the subject or hated it. The attitude towards chemistry at school was similarly classified.

The mean subject, improvement and total scores were compared among the different subgroups of respondents. The mean scores of the individual statements were compared among the different subgroups of the respondents. Student's t-test was used for dichotomous variables and analysis of variance (ANOVA) for the others. Tukey's Honestly Significant Difference (HSD) test was used as the post-hoc test. A p value <0.05 was taken as statistically significant. The software Statistical Package for Social Sciences (SPSS for windows version 9) was used to perform the statistical analysis.

The third part of the questionnaire enquired about the opinions of the students regarding the teaching and learning of pharmacology. They were asked to enumerate the two most significant strengths and weaknesses of the department with regard to teaching and assessment. They were also asked to give two suggestions to improve the teaching and learning of pharmacology. These were analyzed and the most frequently made suggestions were noted down to obtain an idea about emerging trends.

RESULTS

One hundred and thirty-one students participated in the study. Eighty-three (63.3%) were male. Only seven students (5.3%) were graduates. The fathers of 48 students (36.6%) were doctors. The mothers of the majority of students [108 students (82.4%)] were housewives. One hundred and twelve students (85.5%) were educated in English medium schools. One hundred respondents (76.3%) were self-financing while 31 were government-selected. Eighty-five students (64.9%) had studied mathematics at the twelfth standard level.

The mean total score for the 131 respondents was 3.77. The mean subject score was 3.49 while the mean improvement score was 4.02. The mean subject score was significantly higher among students who liked chemistry in school compared to those who were neutral towards (Tukey's HSD, p=0.049) or hated (Tukey's HSD, p=0.029) the subject. The mean subject score was significantly higher among the second semester students compared to the third semester (Students t-test, p=0.013). The mean subject, improvement and total score according to the sex of the respondents is shown in Table 1. The scores were higher among the male respondents but the result was not statistically significant.

The mean total score was significantly higher among the Nepalese respondents compared to the Indians (Tukey's HSD, p=0.028) and the Sri Lankans (Tukey's HSD, p=0.039). The mean total score was also higher among respondents who liked mathematics at school compared to those who were neutral towards the subject (Tukey's HSD, p=0.02). It was also higher among those who liked chemistry at school compared to those who hated the subject (Tukey's HSD, p=0.001).

The mean scores of the individual statements are shown in Table 2. Students agreed that pharmacology had created a

Table 2. Mean scores of individual statements.

Statement*	Mean Score
Favorite subject	3.41
Knowledge base for rational choice of drugs	4.36
Interesting and stimulating lectures	3.4
Closer clinical integration	4.66
Developing problem-solving skills	3.98
Focus on health problems of South Asia	3.4
Practical sessions on rationality of prescriptions	4.1
Modules during clinical years	4.08
Fair assessment process	3.76
Transparent assessment process	3.52
MCQs in assessment	3.62
Assessment tests factual learning	3.23
Capacity for self-directed learning	3.68
Post-graduation subject	2.38
More emphasis on OSPEs & PBLs	4.07

For a full description of the individual statements kindly refer to the questionnaire in the appendix

Table 3. Mean scores of the individual statements according to the nationality of the respondents

Statement	Mean ± SD score			
	Nepalese (n=48)	**Indian (n=74)**	**Sri Lankan (n=9)**	**P value**
Favorite subject	3.58 ± 0.83	3.3 ± 0.85	3.22 ± 0.67	0.149
Knowledge base for rational choice of drugs	4.33 ± 0.86	4.32 ± 0.88	4.22 ± 0.67	0.937
Interesting and stimulating lectures	3.33 ± 1.04	3.3 ± 0.92	3.55 ± 0.88	0.748
Closer clinical integration	4.75 ± 0.52	4.65 ± 0.58	4.55 ± 0.88	0.524
Developing problem-solving skills	4.02 ± 0.86	3.85 ± 0.8	3.89 ± 0.6	0.532
Focus on health problems of South Asia	4.56 ± 0.82	2.96 ± 0.91	3.11 ± 0.78	0.042
Practical sessions on rationality of prescriptions	4.39 ± 0.57	3.97 ± 0.66	3.78 ± 0.44	0.048
Modules during clinical years	4.14 ± 0.65	4 ± 0.69	3.89 ± 0.78	0.4
Fair assessment process	3.77 ± 0.97	3.69 ± 0.84	3.78 ± 0.97	0.873
Transparent assessment process	3.58 ± 0.87	3.44 ± 0.91	3.67 ± 0.71	0.582
MCQs in assessment	3.94 ± 1.16	3.73 ± 1.16	3.22 ± 1.2	0.218
Assessment tests factual learning	3.5 ± 1.05	3.3 ± 0.95	3 ± 0.71	0.295
Capacity for self-directed learning	3.7 ± 0.72	3.65 ± 0.8	3.67 ± 0.71	0.932
Post-graduation subject	2.58 ± 0.85	2.2 ± 0.96	2.4 ± 1.05	0.058
More emphasis on OSPEs & PBLs	4.19 ± 0.74	4 ± 0.86	4.05 ± 0.87	0.179

For a full description of the individual statements kindly refer to the questionnaire in the appendix

knowledge base that would help them in choosing drugs rationally in their future practice. Practical sessions on rational drug use and modules on pharmacology during the clinical years of training were also welcomed. OSPE and PSL sessions should be emphasized more than didactic lectures.

The male students were more in agreement with the statement 'Pharmacology is my favorite subject in the basic sciences' compared to female students (Students t-test, p=0.016). The male students were more in favor of the statement 'There should be more emphasis on objective structured practical examinations (OSPE) and PSL rather than on didactic lectures' compared to the female students (Students t-test, p=0.018). Students whose fathers were not doctors more strongly agreed with the statement 'I will consider pharmacology as one of my subjects for post graduation' compared to those whose fathers were doctors (Students t-test, p=0.045). The self-financing students agreed less strongly with statement number 1 compared to the government-selected students (students t-test, p=0.032).

The mean scores of the individual statements according to the nationality of the respondents are shown in Table 3. The Nepalese students agreed to a greater extent with the statement 'I would like the subject to focus more strongly on the health problems of south Asia with special emphasis on Nepal' compared to the Indian students (Tukey's HSD, p= 0.042) The Nepalese students were more in favor of introduction of practical sessions on rational use of drugs compared to the Indian (Tukey's HSD, p=0.001) and the Sri Lankan students (Tukey's HSD, p=0.016). The mean scores of the individual statements according to the medium of instruction at school are shown in Table 4. The English medium students more strongly agreed with the statement 'The subject has created a knowledge base which will help me in choosing drugs rationally in my future practice' compared to vernacular medium students (Students t-test, p=0.018).

From the main themes, which emerged from the suggestions given by the students, the strengths of the department were PSL, competent teachers, helpful attitude and accessibility of teachers. The student-teacher interaction was good and teachers facilitated the development of concepts. The weaknesses noted were sometimes lectures were boring and the pace of teaching was fast.

The strengths of assessment were fairness, rapid receipt of results and transparency. The weaknesses were strict assessment, lack of multiple choice questions (MCQs) and individual variations in assessment. The suggestions to improve teaching were greater number of hospital visits and PSL sessions and more interactive lectures with greater use of audiovisual aids. Greater number of OSPE spots during the practical examination was also suggested.

Specific identification code was not given to the different student respondents. The anonymity of the respondents was maintained and the results were fed into the SPSS package

Table 4. Mean scores of the individual statements according to the medium of instruction at school

Statement	Mean ± SD score		
	English medium students (n=112)	**Vernacular medium students (n=19)**	**P value**
Favorite subject	3.42 ± 0.87	3.26 ± 0.65	0.087
Knowledge base for rational choice of drugs	4.39 ± 0.81	3.89 ± 0.99	0.018
Interesting and stimulating lectures	3.37 ± 0.94	3.1 ± 1	0.26
Closer clinical integration	4.67 ± 0.61	4.74 ± 0.45	0.645
Developing problem-solving skills	3.91 ± 0.82	3.95 ± 0.78	0.857
Focus on health problems of South Asia	3.54 ± 1.16	3.63 ± 1.16	0.763
Practical sessions on rationality of prescriptions	4.13 ± 0.65	4 ± 0.67	0.410
Modules during clinical years	4.04 ± 0.7	4.05 ± 0.52	0.964
Fair assessment process	3.72 ± 0.89	3.74 ± 0.93	0.951
Transparent assessment process	3.48 ± 0.9	3.68 ± 0.75	0.347
MCQs in assessment	3.75 ± 1.16	3.89 ± 1.24	0.619
Assessment tests factual learning	3.37 ± 0.95	3.28 ± 1.18	0.724
Capacity for self-directed learning	3.71 ± 0.77	3.42 ± 0.69	0.124
Post-graduation subject	2.39 ± 0.93	2.47 ± 1	0.731
More emphasis on OSPEs & PBLs	4.07 ± 0.83	3.94 ± 0.8	0.543

For a full description of the individual statements kindly refer to the questionnaire in the appendix

by two of us (PM & AS) who were not actively involved in teaching the particular batches of students. The association between the current performance in academics and the scores of the student respondents could not be matched. However, the marks obtained in the different examinations in pharmacology was obtained from the department office and it was found that the Nepalese students overall, had done significantly better than the Indian (Tukey's HSD, p=0.027) and the Sri Lankan students (Tukey's HSD, 0.009). The third semester students performed better than the second semester and boys performed better than girls but the results were not statistically significant.

DISCUSSION

Pharmacology at MCOMS is taught during the first four semesters of the MBBS course. The subject is horizontally integrated with the other basic science subjects but vertical integration with the clinical subjects is weak.

Recently we have introduced a system of hospital visits, where students visit patients suffering from diseases of a particular organ system discussed during the previous week in the theory class. The students communicate with the patients, take a history and obtain details of the drugs used during treatment. The management of the condition is then discussed by a teacher of the pharmacology department with a clinical background (with a basic MBBS degree and a MD degree in pharmacology and therapeutics).

As suggested by the revised curriculum of Kathmandu University[11] we have introduced teaching sessions on drug use indicators, essential drug concept, rational use of drugs, analysis of drug promotional materials and P-drug selection. These sessions are activity based and students solve the problems in groups of nine or ten.

Students were of the opinion that there should be more emphasis on PSL and OSPE. Like students from other Asian medical schools, our students had a positive opinion towards PBL/PSL.[12] Research with students in problem-based programmes has shown greater satisfaction with the learning environment.[13]

Pharmacology is not a particularly monetarily rewarding career choice in South Asia and this maybe one of the reasons for the lower rate of agreement with the statement 'I will consider Pharmacology as one of the subjects for post graduation' among students whose parents were doctors.

All the Nepalese students were selected through an entrance examination and had performed better in examinations compared to the students of other nationalities. The association between academic performance and the scores was not explored in the present study. The mean total score was higher among respondents who liked chemistry and mathematics at school. The ability of abstract thinking and conceptualization is shared to a certain extent by the disciplines of mathematics and pharmacology and many basic mathematical principles are involved in the study of pharmacokinetics and pharmacodynamics. This was however not explored in the present study.

Problem-stimulated learning in small groups and competent, friendly, helpful and accessible teachers were the strengths of the department. A previous study had shown that students identified tutor characteristics, a non-threatening atmosphere, clinical relevance and encouragement of independent thinking and problem solving as the most important characteristics of effective small groups.[14] More hospital visits and greater integration with the clinical disciplines was suggested.

The Southern Illinois University School of Medicine teaches pharmacology within a multidisciplinary organ system-based curriculum.[15] Patient cases and joint colloquia involving faculty of different disciplines, including clinicians was employed. At a medical college in Eastern Nepal, the first two years of preclinical study is integrated, partially problem based with an emphasis on early clinical and community exposure.[16] Organ systems with various themes were used to focus the student's learning and each department demonstrated how their subject contributed to the understanding of the theme. Our system of teaching and learning is still largely discipline based and the PSL sessions are conducted only by the department of Pharmacology. Large numbers of students (more than 300 across the four semesters of study), proportionately less number of faculty and physical separation of the basic and clinical science campuses are problems to be overcome before a similar program can be implemented in our institution.

The assessment process is summative and based on short-answer type questions. It mainly tests the ability of students to memorize and reproduce factual information. Often, preparation for the assessment test takes precedence over searching and collating information for the clinical problems presented during the PSL sessions. A similar problem was observed in a Brazilian medical school.[17] Medical schools worldwide are seeking to involve students in curriculum evaluation. Soliciting student feedback regarding the assessment process has been shown to be valuable.[18] It had been previously shown that students want more feedback on their performance in assessments to guide future learning and this was corroborated in the present study.[19]

The practical sessions on assessing rationality of prescriptions and evaluation of drug promotional material were appreciated by the students. We aim to continue and strengthen these sessions in the future. The majority of students were of the opinion that the pharmacology teachers have inculcated in them a capacity for self-directed learning.

The students were in favor of modules on pharmacology and therapeutics during the clinical years of their training. A survey of Italian doctors had considered the pharmacology teaching they received to be mainly theoretical and they were of the opinion that more time and attention should be devoted to issues more closely related to clinical practice.[20] Clinical pharmacology courses have been introduced during the clinical years of training in medical schools.[21, 22] However, the lack of adequate number of faculty may be one of the problems in implementing a clinical pharmacology module in our institution.

Our study had many limitations. Only 131 of the total of 175 students (74.8%) participated in the study. A few student respondents did not complete the questionnaire satisfactorily so their responses could not be included in the analysis. The small number of students involved makes it difficult to extrapolate the results from the cohort and subgroup analysis. A few students might have been uncomfortable about frankly expressing their opinions and criticizing their teachers and may not have completed the questionnaire. Suggestions to improve the teaching and learning of pharmacology were collected on the questionnaire and were restricted to two in number. Focus group discussion to explore and further clarify the emerging themes was not carried out. We did not include a question about the student opinion regarding their grades or class standing in Pharmacology. Specific codes were not given to the different student respondents. The anonymity of the respondents was maintained and we could not explore an association between the student opinions and current performance in academics and related courses. The influence of grades on the opinions expressed in the survey was not explored. This can be explored in future studies. We could not find studies assessing student attitudes to pharmacology in the literature and so could not compare our findings to other studies. Similar studies in other medical colleges in Nepal will provide a larger sample size and will be helpful in making recommendations for modifying the process of pharmacology teaching and learning.

CONCLUSIONS

The students overall, had a positive opinion regarding the discipline of pharmacology with a mean total score of 3.77. The mean subject score was 3.49 while the improvement score was 4.02. The teaching and learning of pharmacology can be improved and a closer integration with the clinical disciplines is required. PSL should be strengthened and 'real' cases from the hospital should be used during the sessions. The sessions on rational drug use and assessment of drug promotional material were appreciated and should be continued and strengthened. The assessment process should be reviewed. MCQs should be included along with the traditional short-answer type questions and problem-based exercise evaluation may be considered.

References:

1) Rangachari, P.K. Basic sciences in an integrated medical curriculum: the case of pharmacology. *Advances in Health Science Education.* 1997; 2: 163-171.
2) Joshi, M.P. Problem-oriented pharmacotherapy teaching In: Adhikari RK, Jayawickramarajah PT, eds. *Essentials of medical education.* Kathmandu: Health Learning Materials centre, 1996: 51-63.
3) Walley, T. Rational prescribing in primary care- a new role for clinical pharmacology. *British Journal of Clinical Pharmacology.* 1993; 36: 11-12.
4) Vestal, R.E., and Benowitz, N.L. Workshop on problem based learning as a method of teaching clinical

pharmacology and therapeutics in medical schools. *Journal of Clinical Pharmacology*. 1992; 32: 779-797.
5) de Vries, T.P.G.M. Presenting clinical pharmacology: a problem based approach for choosing and prescribing drugs. *British Journal of Clinical Pharmacology*. 1993; 35: 581-586.
6) de Vries, T.P.G.M., Henning, R.H., Hogerzeil, H.V., and Fresle, D.F. *Guide to good prescribing.* Geneva: World Health Organization, 1994.
7) de Vries, T.P.G.M., Henning, R.H., Hogerzeil, H.V., Bapna, J.S., Bero, L., Kafle, K.K., Mabadeje, A.F.B., Santoso, B., and Smith, A.J. Impact of a short course in pharmacotherapy for undergraduate medical students: an international randomized controlled study. *The Lancet.* 1995; 346(2): 1454-1457.
8) Shankar, P.R., Mishra, P., Shenoy, N., and Partha, P. Importance of transferable skills in Pharmacology. *Pharmacy Education.* 2003; 3(2): 97-101.
9) Nandi, P.L., Chan, J.N., Chan, C.P., Chan, P., and Chan, L.P. Undergraduate medical education: comparison of problem-based learning and conventional teaching. *Hong Kong Medical Journal.* 2000; 6: 301-306.
10) Michel, M.C., Bischoff, A., Heringdorf, M.Z., Neumann, D., and Jakobs, K.H. Problem- vs. lecture-based pharmacology teaching in a German medical school. *Naunyn-Schmiedeberg's Archives of Pharmacology*. 2002; 366: 64-68.
11) Kathmandu University. *Curriculum for bachelor of medicine and bachelor of surgery (MBBS) Part-one Basic medical sciences.* Third version. Dhulikhel: Kathmandu University, 2001.
12) Khoo, H.E. Implementation of problem-based learning in Asian medical schools and students' perception of their experience. *Medical Education.* 2003; 37(6): 401-409.
13) Kaufman, D.M., and Mann, K.V. Comparing students' attitude in problem-based and conventional curricula. *Academic Medicine* 1996; 71: 1096-1099.
14) Steinert, Y. Student perceptions of effective small group teaching. *Medical Education.* 2004; 38: 286-293.
15) Faingold, C.L., and Dunaway, G.A. Teaching pharmacology within a multidisciplinary organ system-based medical curriculum. *Naunyn-Schmiedeberg's Archives of Pharmacology*. 2002; 366: 18-25.
16) Naga Rani, M.A., Koirala, S., Das, B.P., and Rauniar, G.P. Students' perceptions of the pre-clinical integrated medical curriculum in a health university in Nepal. *Journal of Nepal Medical Association.* 2003; 42: 354-359.
17) Zanolli, M.B., Boshuizen, H.P.A., and de Grave, W.S. Students' and tutors' perceptions of problems in PBL tutorial groups at a Brazilian medical school. *Education for Health.* 2002; 15(2): 189-201.
18) Mennin, S.P., and Kalishman, S. Student assessment. *Academic Medicine.* 1998; 73: S46-S54.
19) Duffield, K.E., and Spencer, J.A. A survey of medical students' views about the purposes and fairness of assessment. *Medical Education.* 2002; 36: 879-886.
20) Furlanut, M. The teaching of pharmacology in Italian medical schools: the point of view of Italian doctors. *European Journal of Clinical Pharmacology.* 1998; 54: 801-804.
21) Tofivic, S.P., Branch, R.A., Jackson, E.K., Cressman, M.D., and Kost, C.K. Jr. Teaching clinical pharmacology and therapeutics: selective for fourth-year medical students. *Journal of Clinical Pharmacology*. 1998; 38: 670-679.
22) Flockhart, D.A., Usdin Yasuda, S., Pezzulio, J.C., and Knollmann, B.C. Teaching rational prescribing: a new clinical pharmacology curriculum for medical schools. *Naunyn-Schmiedeberg's Archives of Pharmacology.* 2002; 366: 33-45.

Appendix

Student attitude towards Pharmacology

Sex: M/ F **Nationality:** __________________ **Graduation:** Yes/ No

If yes, then main subject: **Profession of parents:** Father: _________________________
Profession of parents: Mother: _________________________
Medium of instruction at school: English/ Vernacular

Was mathematics one of your subjects at school (10+2 level)? Yes/ No

Your attitude towards mathematics at school: Liked it Neutral Hated it

Your attitude towards chemistry at school: Liked it Neutral Hated it

Govt. selected /self-financing

For the following statements score using the following key: ***1- strongly disagrees with the statement, 2- disagree, 3-neutral, 4-agree, 5-strongly agree***

1. Pharmacology is my favorite subject in the basic sciences.
2. The subject has created a knowledge base which will help me in choosing drugs rationally in my future practice.
3. I find the Pharmacology lectures interesting and stimulating.
4. I would like Pharmacology to be more closely integrated with the clinical sciences and would like real cases from the hospital to be used during PSL.
5. The subject has helped me to develop my problem-solving and logical reasoning skills.
6. I would like the subject to focus more strongly on the health problems of South Asia with special emphasis on Nepal.
7. I would like practical sessions on assessing rationality of prescriptions and evaluation of drug advertisements.
8. I would welcome modules on Pharmacology and therapeutics during the clinical years of my training.
9. The assessment system in Pharmacology is fair.
10. The assessment process is transparent.
11. I would like MCQs to be included in the assessment.
12. The assessment concentrates on ability to acquire facts rather than on the development of problem-solving skills.
13. The Pharmacology teachers have inculcated in me a capacity for self-directed learning.
14. I will consider Pharmacology as one of my subjects for post graduation.
15. There should be more emphasis on objective structured practical examination (OSPE) and PSL rather than on didactic lectures.

List what in your opinion are the <u>TWO</u> most important strengths and weaknesses of the department with regard to Teaching and Assessment

Teaching:
Strengths: 1) ______________________________
2) ______________________________

Weaknesses: 1) ______________________________
2) ______________________________

Assessment:
Strengths: 1) ______________________________
2) ______________________________

Weaknesses: 1) ______________________________
2) ______________________________

Mention <u>TWO</u> important suggestions to improve the teaching and learning of Pharmacology at MCOMS:
1) ______________________________
2) ______________________________

Using Standardized Patients to Introduce Bioterrorism-related material into a Medical Microbiology and Immunology Curriculum

Gina C. Wesley, Ph.D.[1] , W. Paul McKinney, M.D.[2] and Uldis N. Streips, Ph.D.[3]

[1]Clinical Assessment Programs, [2]School of Public Health,
[3]Department of Microbiology and Immunology
University of Louisville, School of Medicine
Louisville, KY 40292, U.S.A.

Phone: (+)1-502-852-5365 Fax: (+)1-502-852-7531 Email: unstre01@louisville.edu

Abstract

The overall goal of this study was to determine how engagement in basic science courses and retention of the taught material by students could be improved. To achieve this goal we have piloted the use of Standardized Patients in various settings in the Medical Microbiology and Immunology course at the University of Louisville, School of Medicine. The availability of a high quality standardized patient program with extensive, excellent moulage (makeup) capability, allowed the Department of Microbiology and Immunology to present bioterrorism in the context of cases and patients who exhibit symptoms of the diseases studied. This type of approach is appreciated by the students as deviating form classical lecture format and also is retained far better than material which is not visually presented.

Introduction

Since September 11, 2001, there has been an increase in the amount of bioterrorism-relevant information included in medical school microbiology and immunology courses[2]. Recently, (2004) the American Association of Medical Colleges released a report indicating the need to begin teaching about such organisms and offering pedagogical recommendations and available resources[1], and Coico and coauthors released the guidelines for preclerkship bioterrorism curricula[2].

At the University of Louisville, School of Medicine, we wanted to implement these goals into our educational program in an innovative way. Thus, the use of Standardized Patients and an adult learning-centered framework illustrated to medical students in ways that lectures cannot match, the appearance, identification, and progression of bioterrorism-related organisms and the infections they induce. This effort is part of a larger educational initiative of the Center for the Deterrence of Biowarfare and Bioterrorism, a CDC-funded Specialty Center for Public Health Preparadness at our University. More than 7,000 healthcare professionals have been trained in the Commonwealth of Kentucky and surrounding areas. It is necessary to educate such a broad range of personnel to ensure early detection of any bioterroristic event and before the initial infection can spread. It is not probable that initially-infected persons will have access to any specialists and will most likely be treated by a variety of frontline treatment personnel who must be equally aware of the possibilities. If they had to take time to refer such cases to a small bank of specialists, time and possibly additional lives could be lost and the location and source of the infection could go unidentified and uncontained.

This manuscript discusses two specific cases and methods as well as provides a video created in part with Health Resources and Service Administration (HRSA) support, to present bioterrorism material in the medical curriculum within the Medical Microbiology and Immunology course.

Methods and Materials

Cases and sessions
The cases have been adapted from literature available on the website for the Centers for Disease Control and Prevention (www.cdc.gov) or created at the University of Louisville and are described in Figure 1 and Figure 2. The first session describes the release of *Yersinia pestis* in a bioterrorist act in the Louisville area. This case was adapted from the material produced for the American Society of Microbiology by Snyder and Check[7]. The second case was developed at our school and deals with the exposure of a relief worker to smallpox in the Mid East region.

The sessions using these cases employ the Excellence in Basic Sciences (EBS) model that was published in JIAMSE [8]. Briefly, groups of students (from 25 to 95) were presented via email with preliminary information regarding the patient(s) in the case and then in the sessions, by questioning a physician or a 4th year medical student [9], the history of present illness and results of physical examination were revealed. The students determined what laboratory tests need to be ordered and were provided with results from these tests. The students completed worksheets which asked them to list the organ systems affected, major clinical findings, listing of questions they asked the clinician or fourth year student and the laboratory tests they ordered. Finally, student groups, using PDAs, computers, text and notes and small group discussion reached a consensus on the cause of the disease in the case and handed in the worksheets and solution for course credit.

These worksheets were collected for analysis of questions asked and tests ordered and the development of differential diagnosis, as well as identification of the cause of the disease. Student mastery of bioterrorism-related knowledge related to these clinical scenarios and relevant microbiology was tested within our Block testing system.

Standardized Patients and cases utilizing them

A Standardized Patient (SP) is a person who has been coached to accurately and consistently recreate the history, personality, physical findings, and emotional structure and response pattern of an actual patient at a particular point in time. Accumulated evidence of more than thirty years and across several continents has shown that SPs make a significant contribution to medical education in the form of teaching, assessing, and providing feedback to students at all levels of their undergraduate and graduate careers [3,5,6,10]

The SP Program at the University of Louisville school of Medicine is a relatively new one (created July 2000) and the program director and school faculty have eagerly sought rigorous and innovative ways to use this program throughout the medical curriculum, including the basic science courses. The SP program is currently involved in teaching and assessment activities in all four years of undergraduate medical education, as well as several residency programs. It is anticipated that the SP program will become an important component for most GME core competency assessments. Finally, there is an increased interest in using SPs for high stakes testing at both course and programmatic levels.

RESULTS

Two bioterrorism-related clinical cases have currently been adapted to our curriculum.

The first case (shown in Figure 1) describes the release of *Yersinia pestis* in a bioterroristic act in the Louisville area (adapted from Snyder and Check[7]). In preparation for introducing SPs into a session at the University of Louisville, School of Medicine, it was presented as a pilot program for the AMSMIC (Association of Medical School Microbiology and Immunology Chairs) Educational Conference in Myrtle Beach (2004). It utilized a Standardized Patient with moulage for bubonic plague (a bubo and necrosis) for the whole meeting setting with a physician presenting the material as described in (Figure 1). Two medical students asked the questions of the physician and then interviewed the "patient". The "patient" also walked among the meeting participants so they could see and touch the moulage. As the illness progressed, the "patient" decompensated rapidly and then we asked the meeting participants to turn their attention to a METI human patient simulator [4], which provided a physiological model for the disease. The medical students resuscitated the simulator, using skills that they had learned in their local Advanced Cardiac Life Support training course. This presentation was highly received at the AMSMIC meeting. When the same case was then presented for the first time at the University of Louisville School of Medicine to the 2nd year class (95 students) by a physician using the EBS method and a Standardized Patient circulating, the response was equally high (Figure 2) and suggests that this is indeed a viable method for presenting bioterrorism information to medical students.

The second case (Figure 3) represents smallpox, contracted by a missionary on service in a Mid Eastern country and was presented to small groups of 25 to 30 medical students, using senior students as the discussion leaders. The Standardized Patients circulated through each room and presented all 3 stages in the smallpox infection cycle, demonstrating high fever, lower back pain and facial lesions, as the case was being developed. For this case, the medical students filled out worksheets for course credit, as described in the Material and Methods section. A review of the student worksheets revealed that the medical class bifurcated into two distinct groups. Those students who listed more and detailed questions for the fourth year students also ordered more tests, while those with few questions ordered less and less specific laboratory tests. Those students who asked more and ordered more may excel in those areas or may have been more engaged in the exercise. Verbal feedback from the students indicated that the exercise was more enjoyable and would be remembered more vividly than a standard didactic lecture. The class of 124 (with 117 responding) rated the exercise at 4.1 on a scale of 1 to 5 with 5 being best. The microbiology questions on the Block Test on the bioterrorism agents discussed in these cases revealed that the class averaged at 82% correct answers.

To further aid in the presentation of this material, a video was constructed using Standardized Patients with moulage to demonstrate smallpox and differentiate from chickenpox. This was shown at the AMSMIC meeting and is regularly shown at the University of Louisville in the context of the course and has been distributed to other medical schools. (Attached video clip).

Both of these cases could be made more challenging for students by incorporating the use of the human patient simulator [4], which is programmed to simulate late stages in both of these diseases, and which would require extensive intervention by the students to treat the patient, as we demonstrated at the AMSMIC meeting.

DISCUSSION

This investigation has served as a pilot for integrating bioterrorism-related material in a meaningful way into the curriculum of the Medical Microbiology and Immunology course at the University of Louisville School of Medicine. We have also determined the value and any restrictions to using Standardized Patients as a teaching and learning tool in basic science courses in general. Based on our results, we believe the activities and learning situations outlined in this manuscript provided the medical students with an active learning situation that enhanced their educational experience in general and learning points about bioterrorism specifically. The use of the video on poxviruses, coupled to small group or large group sessions using SPs and the cases outlined above could constitute the start of a solid bioterrorism-related curriculum for any medical school. Also, development of other clinical cases, illustrating different, dangerous organisms will provide variety as well as additional exposure to this information.

In addition, we will continue to implement SPs into Medical Microbiology and Immunology and other basic science courses and further experience will allow us to streamline the use of this tool for the better education of our students at the University of Louisville.

CONCLUSIONS

This manuscript introduces a relevant, potential addition to the curricula of most of our medical schools. The use of standardized patients amplifies the opportunities for presenting bioterrorism-related material to the medical students and adds a striking visual component to their experience. Coupling the use of the SPs to small group discussion, as done by the EBS methodology makes this material more memorable, interesting, and educationally relevant.

REFERENCES

1. American Association of Medical Colleges. "Training future physicians about weapons of mass destruction: Report of the expert panel on bioterrorism education for medical students. ", 2004. http://www.aamc.org/newsroom/bioterrorism/bioterrorismrec.pdf.
2. Coico, R., Kachur, E., Lima, V., and Lipper, S. Guidelines for preclerkship bioterrorism curricula. *Academic Medicine*. 2004; 79: 366-375.
3. Duke, M.B., Griffith, C.H., Haist, S.A., and Wilson, J.F. A clinical performance exercise for medicine-pediatrics residents emphasizing complex psychosocial skills. *Academic Medicine*. 2001; 76: 1153-1157.
4. Loyd, G.E., Lake, C.L., and Greenberg, R.B. Practical Health Care Simulations. Elsevier, Philadelphia, PA. 2004.
5. Ram, P., van der Vleuten, C.P.M., Rethans, J.J., Grol, R., and Aretz, K. Assessment of practicing family physicians: comparison of observations in a multi-station examination using standardized patients with observation of consultations in daily practice. *Academic Medicine*. 1999; 74: 62-69.
6. Rethans, J.J., Sturmans, F., Drop, R., and van der Vleuten, C.P.M. Assessment of the performance of general practitioners by the use of standardized (simulated) patients. *British Journal of General Practice*. 1991; 41: 97-99.
7. Snyder, J.W. and Check, W. Bioterrorism threats to our future: the role of the clinical laboratory in the detection, identification, and confirmation of biological agents. *American Academy of Microbiology and American College of Microbiology Colloqium Report.* 2000.
8. Streips, U.N. and Atlas, R.M. Fourth year students are effective case discussion leaders. *Basic Science Educator*. 2001; 10: 23-26.
9. Streips, U.N. and Bain, K.R. Excellence in Basic Sciences: A novel model for instruction of medical students. *Journal of the International Association of Medical School Educator.s* 2003; 13: 40-44.
10. Wass, V., Jones, R., and van der Vleuten, C.P.M. Standardized or real patients to test clinical skills? The long case revisited. *Medical Education*. 2001; 35: 321-325.