COMPUTER APPLICATIONS IN BASIC SCIENCE EDUCATION

Associate Editor: W. Marshall Anderson, Ph.D.

Think back to about fifteen or twenty years ago, a time we will call BC (Before Computers). How did we in the basic medical sciences get along? We had only electric or manual typewriters, grade books, hand held calculators, and a telephone. But our world and our productivity changed dramatically with the appearance of a computer on our desk. Now think back eight or ten years ago, a time we will call BI (Before Internet). Some of us could communicate via fax, and we still used the telephone, but there was no e-mail, and for most of us no worldwide web. Our world changed again, perhaps even more dramatically when our computer became a networking device. We now use computers for almost every aspect of basic medical science education. Wordprocessing has become essential for preparing lectures, cases, exams, manuscripts for publication, student and course evaluations. Spreadsheet applications are used to calculate and keep track of grades and other class data. Plotting and drawing applications are used for diagrams and figures for lectures, cases, and exams. There are a number of teaching applications (both interactive and non-interactive) for most, if not all, the basic medical science disciplines. Computer networks are used for printing, sharing applications and resources, e-mail communication, gaining and retrieving information through the search of literature databases and viewing journals online, and perhaps most useful of all, the worldwide web for obtaining and sharing information and for teaching applications. It may be accurate to say that today the most valuable skill for faculty and students, both now and in the future, is the ability to use a keyboard and a mouse!

As the newly appointed Associate Editor of Computer Applications in Basic Science Education for the Basic Science Educator, *I would like to explore the variety of ways we use computers in our profession of basic science education, including what works and what does not. As the lead-off article in this endeavor, we chronicle the experiences of an international team of basic scientist and clinicians collaborating via the internet. This has resulted in a series of interactive computer assisted learning (CAL) modules which serve to integrate basic science and clinical medicine. To make these CAL modules as widely available as possible, the collaborators converted each exercise to HTML/ Javascript version so it might be run interactively on the worldwide web using a graphic viewing browser.*

This project is but one example of the focus for this column. I invite all who have "tales to tell" about the application of computers in basic science education to contact me (via e-mail, of course) with their ideas for articles for future issues. <wanders@meded.iun.indiana.edu>.

Computer Assisted Learning in Medical Biochemistry on the World Wide Web Accomplished by Electronic Collaboration

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INTRODUCTION

A small international group of basic medical scientists and clinicians have collaborated to develop computer assisted learning (CAL) tutorials that differ from conventional computer assisted instruction (CAI) materials in that their goal is to advance students' operative knowledge rather than merely providing additional information. By operative knowledge, we mean knowledge gained through an active process that can be utilized in making reasoned decisions. The resulting series of patient-based tutorials feature clinical scenarios that permit students to explore important medical problems in a clinical setting while integrating their recently acquired knowledge of biochemistry. Thus, our emphasis has been on active learning, much as occurs in a student-directed problem-based learning curriculum. This approach is described below and referenced

at <http://www.umanitoba.ca/faculties/medicine/biochem/tutorials/introduction.html>

ELECTRONIC CASES

In the first tutorial, "George", a patient in unexplained coma, is presented to the students who explore biochemical and physiological aspects of possible causes of coma and apply this new knowledge to interpreting laboratory findings. This exploration leads them to consider the biochemistry and pathophysiology of alcohol consumption and to discover that one of its side effects is causing his coma. Students learn that ethanol is metabolized by more than one pathway in the body. They gain an appreciation for the physiologic consequences of these pathways and ultimately are asked to apply the knowledge gained in this tutorial to suggesting an appropriate treatment for "George".

In the second tutorial another patient, "Frank", presents with abdominal swelling and what first appears to be jaundice. Students can examine present, past, and family medical history, physical examination results and various laboratory results including clinical chemistry, ultrasound, and liver biopsy. After exploring liver function and finally, iron metabolism in detail, students will conclude he is suffering the consequences of long-term iron overload. They are guided to a diagnosis based on the knowledge they have gained, and must then determine the correct treatment for "Frank". Throughout the tutorial, students may review the information they have encountered by clicking on "findings" in a "pull down menu".

Electronic collaboration also allowed us greater success in joining the forces of basic scientists and clinicians comprising this international group to more completely intregrate basic and clinical science throughout each tutorial.

"Frank" appears again in the third tutorial, this time with true jaundice. After exploring the causes, signs, symptoms, and lab findings (both blood and urine) of the major types of jaundice, students are invited to apply their new understanding to making a diagnosis based on the clinical scenario and test results. Throughout the tutorial, students are asked to identify components in blood and/or urine, which would be elevated in a particular type of jaundice.

Although there are two names for the patient, "George" and "Frank", this is really the same patient. By following the same individual through a series of clinical problems and scenarios, we have mimicked a technique used in a popular medical biochemistry textbook.[1] Students have the opportunity to follow a patient through a problem while learning basic biochemical facts associated with the clinical problem, much in the same way a paper problem-based learning case would be presented. The major difference however, is that the student is acquiring knowledge and solving the problem on his/her own, rather than through interactions with others in a small group. This is more analogous to a physician in actual private practice.

In all three tutorials, students interact with the tutorial by entering answers via keyboard to questions at various parts of the tutorial. A correct answer is rewarded with positive feedback and the ability to proceed further, while a wrong answer elicits probing questions and encourages students to "backtrack" and review information before attempting another answer. Rhetorical questions are also posed at various stages to help students think about this problem and consolidate their knowledge base.

THE TUTORIAL DEVELOPMENT PROCESS

The starting points for these tutorials were initially created by Marcel Blanchaer in rough draft form on the Macintosh computer using the SuperCard authoring application. They were then sent electronically to each of the collaborators who, through extensive e-mail dialogue, provided revisions and enhancements to the original concept. Because of computer capabilities and e-mail communication, we were able to assemble a working group, which even ten years ago, would have been virtually impossible because of the geographical distances between individuals. Electronic collaboration also allowed us greater success in joining the forces of basic scientists (biochemists) and clinicians (pathologist) comprising this international group to more completely integrate basic and clinical science throughout each tutorial.

Very often conflicts in opinion occurred during the development process. These conflicts were resolved using the "Delphi technique"[2-3] which was continued iteratively until programming "bugs", and errors in concept and content had essentially been corrected. Each tutorial underwent twenty or more revisions and it was of interest to all collaborators that the "final product" often only vaguely resembled the initial rough draft. Once each tutorial was completed, it was posted on the worldwide web (WWW) for downloading and use at <http://www.umanitoba.ca/faculties/medicine/biochem/tutorials>. Screens in each tutorial display the names, addresses, and e-mail addresses of all collaborators, with an invitation for students and other users to contact them with comments/suggestions for improvements. Comments provided by both students and faculty members guided further revision of the tutorials.

Admittedly, one major problem with CAL/CAI tutorials is that generally they tend to be computer platform specific. This is particularly true with the three tutorials described above, which do run as "stand alone" applications, but only on the Apple Macintosh computer platform. However, it is now possible to construct interactive modules that run on the WWW and which are independent of the end-user's platform. Two of our tutorials have already been converted to HTML/Javascript versions that run interactively on browsers that allow graphic viewing. They are "Frank", available at <http://www.umanitoba.ca/faculties/medicine/biochem/tutorials/frank/titlecd.html>, and Frank during his second episode Jaundice_II, at <http://www.umanitoba.ca/faculties/medicine/biochem/tutorials/frank_II/start.html>. Such conversions compatible with multiple receivers make these case

studies more widely available to students throughout the world and accessible in an interactive manner. This is very similar to the original Macintosh SuperCard versions, which are still available for downloading.

To better monitor usage of these tutorials, we have embedded counters in each of the HTML /Javascript tutorial versions at various selected locations. In this way we can track the number of users progressing through only part of the tutorial versus completing the entire exercise. We are continuing to refine the latest tutorial utilizing the comments provided by our users.

CONCLUSIONS

Two benefits derived from this type of collaboration are first, the wide variety of expertise of individual collaborators which helped resolve content conflicts; and second, the ability to evaluate the tutorials for compatibility with different Macintosh models and by students in different learning environments. In addition, students on several different continents contributed to the final products by testing and commenting on knowledge they gained from each tutorial and the benefits/drawbacks of this method. These comments were highly valued in the final revision process.

Although electronic collaboration of this type might, at first appear cumbersome, it proved to be a quick and easy way to incorporate suggestions, ideas and corrections into a final usable product. Accomplishing the same goals using conventional techniques, such as mailing the tutorial on disk to each collaborator, or printing each screen and faxing it to all, would have involved much more time and effort. Each collaborator's unique expertise was incorporated and proved invaluable to the design and overall "flow" of the tutorial.

Interestingly, most of us in this collaboration have still never met in person. Yet not only the resultant tutorials, but each of us has also benefited from the shared knowledge used in developing these problem-solving exercises. Electronic collaboration provided the added benefit of opportunities to establish both satisfying professional interactions and personal friendships with colleagues at great geographic distances.

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ANNOUNCEMENT

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