DEVELOPMENT OF A MULTIMEDIA PROGRAM THAT CROSSES TRADITIONAL DISCIPLINE BOUNDARIES

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Abstract

This paper presents an overview of the development of a multimedia program called "The Patient Under The Microscope", which explores the key role of cells in health and disease. This CD-ROM-based program was designed to meet the learning objectives related to cell biology, histology and pathology in medical and paramedical curricula at The University of Melbourne. As such, it demonstrates the link between changes at the cellular and molecular level and the signs and symptoms of disease in the patient. It is used for computer-aided learning (CAL) based tutorials, as well as serving as a resource supporting more traditional microscope-based practical classes, lectures and problem-based learning in the medical curriculum. The program is now an integral part of a variety of courses involving First to Third Year level students within the Faculty of Medicine, Dentistry and Health Sciences. It is currently used by more than 1000 students per year and its usage is expanding.

Keywords

multimedia, cell biology, histology, pathology, clinical problems

The Need for the Program

Development of this program was commenced at a time when medical education was undergoing revolutionary change on a global scale. This change is ongoing and involves three fronts: the widespread adoption of problem-based learning, the introduction of multimedia technology, and the growing impact of cell biology.

Traditional methods of teaching are being discarded as inefficient and unchallenging for both students and teaching staff. Instead, medical schools worldwide are turning to problem-based learning (PBL) (Barrows & Tamblyn, 1980). At the same time, formal staff-student contact time is being reduced in favour of opportunities for self-directed learning. This approach is in line with the recommendation of the General Medical Council for the adoption of methods which promote "learning through curiosity, exploration of knowledge and the critical evaluation of evidence" (GMC, 1993). PBL blurs the boundaries between disciplines and allows students to acquire an integrated knowledge based on their experience of the type of problems they will encounter in their professional lives. Furthermore, PBL addresses the issues of curriculum overload and repetition, and reduces the need for rote-learning. It is thus a sound educational strategy, based on research into how students learn most effectively (Walton & Matthews, 1989).

Multimedia technology is also being widely adopted and utilised to stimulate learning by enhancing the role of reason and imagination. Computers offer the ability not only to organise and store large databases, allowing ease of access to an impressive amount of information including images and animations, but also to allow self-directed, self-paced learning with opportunities for feedback at critical points in the learning process. Not surprisingly, overseas experience has shown that the introduction of PBL has increased the demand for computer-assisted learning. Clinical reasoning skills and basic biomedical knowledge are acquired in PBL by discussing cases with fellow students and by consulting appropriate resources. However, to be effective, students must be provided with a framework as an aid to assimilating the enormous amount of available information. This is a major aim of the program outlined in this paper.

Medicine itself is also going through revolutionary change, particularly in the field of cell biology. Rapid advances are being made in the understanding of disease at a molecular and genetic level. This new knowledge is bringing with it improvements in diagnosis and treatment. It is therefore essential that students are able to understand these advances and the way in which they are impacting on patient diagnosis and management. Because of the central role of the cell in determining how disease is expressed, histology and pathology offer the crucial links between events taking place at a cellular and molecular level and the manifestations of disease in the patient. Understanding this link will be essential to the medical practitioners of the future. The program described in this paper provides a resource for exploring the link between cellular and molecular events, and the clinical expressions of disease.

Project Concept

By focussing on the structure and function of the human body at the level of cells and tissues, this program seeks to provide a framework for understanding clinical problems. Images obtained from normal and abnormal tissues are used to simulate diagnostic examinations such as would be performed on biopsy specimens from patients. These images are complemented by diagrams, animations, text and appropriate key questions designed to direct students to establish their own understanding of microscopic anatomy and patterns of disease. By combining this with macroscopic images of diseased organs or tissues, together with common presenting complaints, symptoms, clinical signs and diagnostic investigations, the student is guided to an appreciation of how the clinical manifestations of disease arise and can be interpreted.

Educational Objectives

The Patient Under The Microscope was designed for use by students in conjunction with the systems-oriented learning environment currently being used at The University of Melbourne. This CD-ROM-based program takes the form of modular teaching units which can be used as a self-paced learning resource, incorporating formative assessment.

The program aids students in the fundamental task of integrating knowledge. By exploring the relationship between structure, function and malfunction (patterns of disease) the program provides a set of unifying principles that complement, enhance and extend the problem-based, system-oriented approach adopted by the medical faculty in combining the basic pre-clinical subjects.

A series of modules have been produced which allow students to explore a topic of interest, related to a clinical problem. An example of this is skin cancer. Interactive tutorials allow students to study the histology of skin, including the nature of the epithelium, the way in which the epithelium is adapted to its functions, and the dynamics of the epithelial cell population. Students are able to view images of skin selected to illustrate the relationship between structure and function. The students are then led on to explore the changes in cell morphology and behaviour associated with damage caused by solar radiation, as well as viewing macroscopic specimens of skin cancer.

Regular self-assessment provides important feedback to the student at strategic points in the

learning process, while learning remains essentially self-directed and self-paced. The modular units are designed in such a way that students are able to begin at any level and move forward to develop their understanding of new concepts, or move back to revise basic information which may need reinforcement to fully comprehend the clinical problems they are exploring. This is very useful as students reviewing a particular area are not necessarily at the same point in their course, or in their individual development.

Formative assessment has been incorporated into the tutorial programs in such a way as to encourage clinical reasoning. At the end of modules, self-assessment tasks called "Diagnostic Decisions" are offered. Alternatively, the user may choose to attempt a "Multiple Option Quiz", which is programmed to function like a multiple-choice test. At the end of the quiz a score sheet is produced with an opportunity to check on the answers. Self-assessment of this type is particularly sought-after by students engaged in PBL. A special effort has been made to ensure that the goals of formative assessment are matched to the goals of summative assessment, to further reinforce student learning (Newble & Jaeger, 1983).

Scope

The program is divided into an INTRODUCTION and four colour-coded levels: CELLS AND BASIC TISSUES, ORGAN SYSTEMS, DISEASE PROCESSES and CLINICAL PROBLEMS. The INTRODUCTION explains issues such as the importance of thinking in terms of planes of section, image resolution and the roles of light and electron microscopy. The CELLS AND TISSUES level includes information on cell organelles, cell surface specialisations and basic tissue types. The ORGAN SYSTEMS level contains information on the way specialised cells and basic tissues are organised to form entities such as the skin and the cardiovascular system. The DISEASE PROCESSES level outlines basic pathological processes. The CLINICAL PROBLEMS in the final level have been selected to illustrate basic principles, illustrating how cell injury and reactions to injury are manifested clinically.

The scope of this program is therefore unusual. No similar resource exists, either in a multimedia or conventional textbook form. A reasonable volume of educational material is available to assist with the teaching of histology and pathology, including computer-aided learning programs. However, in no case is the teaching of histology and pathology fully integrated in this way. Current texts and multimedia programs of pathology assume a basic knowledge of histology and cell biology, whereas histology texts and programs do little more than hint at pathological processes. We have found from experience that students are often unable to make the links between the two and with clinical practice.

Interface and Navigation

The program is designed in modular units. Gateway screens within the levels direct students to related modules. Within each module there is a linear progression between screens which eventually returns the user to the initial gateway screen. On launching the program the user enters the Home Screen and is presented with a choice between the INTRODUCTION, any of the four levels of the program, or a QUIT button for exiting the program. Any of the levels can be accessed directly by clicking on the appropriate button which activates the microscope-based navigation zone on the left of the screen. Clicking on the microscope stage displays a menu of module gateways.

Throughout the program, a button displaying the program's microscope icon is located in the lower left of the navigation zone. Clicking on this icon will always return the user to the Home Screen. In addition, a directory icon is always accessible. Clicking on this icon opens a window which displays definitions of terms and directs the user to further information within the program or in course-related textbooks. Interactivity within the program includes the use of active text linked to definitions and overlays to clearly indicate key features of images. Animations show the consequences of structural and functional changes. Users are also challenged to "build-your-own" organelles or tissues, or follow a disease process.

Implementation

The program has been aimed primarily at medical students and incorporated into the curriculum of the medical course. However, the interactive self-paced tutorials and self-assessment have also proven to be a valuable resource for students in paramedical courses, such as dental science, biomedical science, optometry and physiotherapy. Modular units have been selected by staff for use as CAL-based tutorials, introductory material for practical classes, course-specific material reinforcing or expanding upon lectures, material formally incorporated into problem-solving exercises, and bridging courses for overseas, graduate and lateral entry students, etc.

Evaluation

The program has been evaluated by means of expert review, student questionnaires, direct observation of student use, focus group interviews, individual interviews and formal assessment measures. All users agreed that the program was easy to use. In response to the assertion that "the computer-based multimedia program helped me to learn effectively" a score of 4.6 on a scale of 5 was achieved. Over 80 percent found the CAL "interesting" or "extremely interesting" (i.e. scored 4 or 5, respectively, on a scale of 0 to 5). Staff noted that students were readily engaged by the program and often spontaneously explored modules beyond the requirements of the class, or even of their course. There was also a high level of demand to access the program outside class hours. Above all, the questions raised by students often indicated a deeper understanding of topics than had been the case previously.

Conclusions

Morphology has traditionally provided an explanation of clinical signs and symptoms, whether at a macroscopic or microscopic level. There is now an increasing need for extension of this process to provide an explanation of the pathophysiology and molecular mechanisms of disease. The first steps in this integrative approach to the teaching of histology and pathology have been taken through the development of a new interactive multimedia program. The project outlined here has achieved an unprecedented degree of integration of basic and clinical sciences and allowed an emphasis on concepts that cross over disciplinary barriers.

References

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