EXPANDING THE USER BASE OF COMPUTER FACILITATED LEARNING RESOURCES

Kristine Elliott
Faculty IT Unit, Faculty of Medicine, Dentistry and Health Sciences
The University of Melbourne, Australia
kaelli@unimelb.edu.au

Gary Anderson
Department of Pharmacology
The University of Melbourne, Australia
gpa@unimelb.edu.au

Lou Irving
Department of Respiratory Medicine
Austin & Repatriation Hospital, Australia

Andrew Bonollo
Biomedical Multimedia Unit
The University of Melbourne, Australia
abonollo@unimelb.edu.au

Abstract

This paper reports aspects of educational design that are capable of broadening the user base of a computer facilitated learning (CFL) resource. It uses as a case study the Gas Exchange Program, a self-directed learning (SDL) module originally designed to demonstrate the components and processes involved in the transfer of oxygen and carbon dioxide between the lungs and tissues. The intended users of this module were tertiary students undertaking degree courses in Medicine, Dentistry, Optometry, Physiotherapy and Science. More recently however, components of this program have been used in primary school classrooms to explain the different components of body systems and their function. Attributes of the Gas Exchange Program that have contributed to its successful transition into the primary sector are the extensive use of visually rich graphics and interactive animations, along with its modular design.

Keywords

multimedia, computer facilitated learning, problem-based learning, educational design, visual media

Background

In recent years, significant effort and funding has been directed towards the development of multimedia programs as learning resources for problem-based learning (PBL) curricula in the Faculty of Medicine, Dentistry and Health Sciences at the University of Melbourne (Keppell, Kennedy, Elliott & Harris, 2001). The Gas Exchange Program is an example of such a resource, designed to demonstrate the components and processes involved in the delivery of oxygen from the lungs to tissues, and the removal of carbon dioxide from the body. These processes are known as gas exchange. Over many years of teaching this topic, the developers of the program recognised a need for a tool that helped students visualise the components and processes involved in gas exchange. Indeed, many of the current textbooks used to teach this topic use symbols to represent these components. This provided the catalyst for creating a multimedia program that visually traced the physiological path of inhaled 0_2, and the extraction of $C0_2$.

The Gas Exchange Program is currently being used to support several of the weekly medical problems presented to 250 students enrolled in the PBL medical course. The content of the program is designed to complement second year problems about acute altitude (mountain) sickness, pulmonary oedema, asthma, and cystic fibrosis. Further details about how students use the program are discussed in “Use in a PBL curriculum” (see below). In addition, the program is being utilised as a self-directed learning (SDL) resource for revision by Physiotherapy, Dentistry and Physiology students.

This year the Gas Exchange Program was one of a number of computer facilitated learning (CFL) resources used in a pilot study undertaken in conjunction with the Australian Kidney Foundation (online) to introduce a *Kids need Health* education program into primary schools. The aim of this exercise was to educate children about healthy lifestyles, for example, the relationships between nutrition, exercise, relaxation and healthy body organs. To achieve this objective, students needed to have an understanding of body systems and their function. The Gas Exchange Program was used to demonstrate the role of the airways, lungs, heart and blood vessels in human body function. The following sections describe the educational design of this program, how it is used in both the PBL curriculum and school class room, and ends by identifying the aspects of design that have allowed it to be used in such diverse learning environments.

The Gas Exchange Program

Educational Design

The structural organisation of the program was based on the journey of inhaled 0_2 through the airways, across the alveolar-capillary membrane into the capillary where it is taken up by erythrocytes, transferred into tissues, and then the extraction of $C0_2$ produced in tissues. The journey can be summarised in five steps: Ventilation, Gas Exchange, Blood Gas Transport, Heart and Vessels, and Tissue Transfer. The components and processes of each step are explained in self-contained units. Within each of the five units content was arranged in a hierarchical order beginning with simple concepts and moving onto more complex ones.

A modular design with a structure of small, self-contained units has been advocated by Minimalist design theory to exploit people’s natural learning tendency to make sense of a situation (Boyle, 1997). “Learners could then choose the units useful to support their activity, rather than being constrained to a predefined learning sequence” (Boyle, 1997, p. 13). However, to support students wishing to follow the sequence of physiological events taking place, each step was represented by a pictorial icon on the introductory page of the program. Students then clicked on an icon to navigate to a particular unit.

Rich visual effects including three-dimensional (3-D) graphics and interactive animations have been used extensively. These are mainly representational; graphics that share a physical resemblance with the object or concept being portrayed (England & Finney, 1999). On entering the program, the user views a zoom-in sequence that focuses down from a macro to a micro view of lung structures and ends with an animation of an alveolar unit. The aim of this introductory sequence was to place the processes being demonstrated in relation to body components. Zooming techniques are commonly used in visual media to draw a viewer’s attention to something (England & Finney, 1999), however, they have also been used here to enable viewers to grasp the relative size differences between components.

Another visual technique employed is the use of two moving images running simultaneously side by side on the same screen. This method is used in the Ventilation unit: on the left hand side of the screen a 3-D fly-through showing a close up of the inside of the nasal passage, trachea, bronchial tube and alveoli plays. Here, the graphics have been used to encouraged students to immerse themselves in the journey and imagine that they are 0_2 moving along the passages. "The strength of graphics is to provide a visual stimulus that can trigger a reaction in the user" (England & Finney, 1999 p. 162). The adjacent graphic on the right hand side provides a more functional role by showing a macro view of the molecule's location. Because these sequences play continuously until the viewer chooses to move on, there is ample opportunity for viewers to revise the information.

Use in a PBL Curriculum

The Gas Exchange Program is currently being used as a learning resource for the second year medical problems about respiratory illnesses. Following a small group session where the weekly problem is presented online, students endeavour to formulate hypotheses about the underlying cause of the problem and the mechanism of each hypothesis. Students then undertake a period of SDL where they obtain further information to help them prioritise and decide between their hypotheses. It is during this period that students use the Gas Exchange Program.

It was planned that the program would take one hour to complete. A paper-based workbook was produced as an accompaniment. It contains exercises for students to undertake as they progress through the program. The following are examples of the type of interpretive questions and calculations: "Capillaries in skeletal muscle are about 25 μm apart. Calculate the diffusion distance ratio" (Introduction), "Why are there so many alveoli?" (Ventilation), "Explain your understanding of Fich's Law. In some diseases the A/C membrane becomes thickened. Do you think a given level of thickening would tend to have a greater effect on 0_2 diffusion into the blood or $C0_2$ diffusion out?" (Gas Exchange).

The Gas Exchange Program is also integrated with lectures and a "wet" laboratory session where students investigate the effect of relaxant drugs such as Ventolin in solution, on contracted, smooth muscle of lung. Following this period of formal and SDL, students meet to discuss the more plausible hypotheses behind the medical problem. At the week's end, final clinical impressions of the problem are made available to enable students to compare their own diagnosis and follow up, to one made by an expert.

Informal questioning of students by the developers, along with feedback from general departmental evaluation has indicated that students regard the Gas Exchange Program as a valuable resource for learning about the basic scientific principles underscoring respiratory illness. Students with no background in physics found it particularly useful. Students also liked having a workbook that they could take away with them.

Use in a Classroom

The Gas Exchange Program was used as part of an interactive session with three groups of 20, Year 6 students. To begin, the medical context of the program (why humans need 0_2, the role of the airways, lungs, heart and blood vessels in human body function) was introduced orally by a facilitator/tutor. Students were then guided through the program by the facilitator. As they observed the visual zoom-in sequences, 3-D fly-throughs and interactive animations, students were encouraged to raise questions about what they were viewing. The answers to these questions often initiated further questioning. In some cases the visuals were played many times over before students decided to move on. Each session lasted about half an hour.

The content that was shown to the Year 6 students was selected for its ability to demonstrate the learning objectives of the session (detailed above in "Background"). The more advanced material contained in the program was not included in the session. Because of the structural organisation of the program–each unit beginning with simple concepts and moving onto more complex ones–it meant that generally the first four screens of each unit were used.

To determine whether the session had successfully achieved it's educational aim of demonstrating the role of the airways, lungs, heart and blood vessels in human body function, students were asked on completion to identify something about the airways, lungs, heart or blood vessels, that they didn't know before the session. Every child was able to nominate an answer to this question, although at different levels of understanding. Student responses included knowing; the location of the heart and lungs within the body, that carbon dioxide was exchanged for oxygen (at the alveolar membrane), and the physical appearance (structure) of the heart, lungs and arteries.

The informal interactive sessions simulated a high level of interest for the Year 6 students. Student comments throughout the sessions showed their appreciation of the visual graphics. Feedback from regular teachers revealed that students continued to ask questions about aspects of the program well after the session had finished. Some of the questions raised by students included, "What would happen if eight oxygen molecules attached (to the red blood cell)?", "Why do only half the number of blood cells come out of the heart?", and "What is that thing (molecule) going away as the oxygen crosses the membrane?".

Conclusion

This case study highlights the possibility of expanding the user base of computer facilitated learning (CFL) resources beyond that of the intended target audience. The Gas Exchange Program has been used in two very diverse learning environments: a medical PBL curriculum and a primary school classroom. The style of teaching and the mode of delivery of the material were varied in each case to accommodate the different levels of prior knowledge of students. In the PBL curriculum the program was used as a computer-based, SDL resource. In the primary school classroom a facilitator guided students through the program. Although informal evaluation suggests that the learning experience of students was enhanced by the extensive use of visually rich graphics and interactive animation in the program, more rigorous evaluation is required to determine the effects of the facilitator and the mode of delivery on learning outcomes.

Significant amounts of time and funding are often invested in the creation of CFL resources. By considering the issue of transportability at the conceptual design phase of a project it may be possible to expand the final user base of a program. The re-use of learning resources in different contexts increases the number of final users of a program, and in so doing preserves the original investment of time and expense.

References

Australian Kidney Foundation. [Online]. Available: http://www.kidney.org.au [13th September 2001].

Boyle, T. (1997). *Design for multimedia learning*. Europe: Prentice Hall Inc.

England, E. & Finney, A. (1999). *Managing multimedia project management for interactive media.* Great Britian: Addison-Wesley

Keppell, M., Kennedy, G., Elliott, K. & Harris, P. (2001). Transforming traditional curricula: Enhancing medical education through problem based learning, multimedia and web based resources. *Interactive Multimedia Electronic Journal of Computer Enhanced Learning, 3* (1), April, 2001. [Online]. Available: http://imej.wfu.edu/articles/2001/1/03/index.asp [13th September 2001].

Acknowledgments

The authors wish to thank Julian Murphy for the opportunity to participate in the pilot study.