Visual Triggers: Improving the Effectiveness of Virtual Patient Encounters

Kristine A. Elliott
Faculty of Medicine, Dentistry and Health Sciences
The University of Melbourne, AUSTRALIA
k.elliott@medicine.unimelb.edu.au

Mike Keppell
Faculty of Medicine, Dentistry and Health Sciences
The University of Melbourne, AUSTRALIA
m.keppell@medicine.unimelb.edu.au

Abstract

The new medical course that began at the University of Melbourne in 1999 employs elements of both Problem Based Learning (PBL) and computer technology for teaching. Visual triggers are being used in this course to enhance the effectiveness of virtual patient encounters. Digitised photographs, Shockwave movies and digitised video segments are used as entry points to on-line problems of the week. These triggers are intended to set the stage for the problem by introducing students to a virtual patient, and to some of the circumstances surrounding the hypothetical situation. The design of the trigger was critical to the overall success of each problem, since it represented the first exposure of students to the scenario. Our aim was to create images that would "suspend the disbelief" of students and allow them to approach each problem as if it were a real life clinical case. This paper describes and discusses the processes that were formulated to produce triggers required for eighteen problems, used by first year medical students in 1999. It covers the translation of the initial conceptualisation of a scenario by medical experts into a visual trigger form, multimedia design and development, and evaluation of the final product to determine its effectiveness for student learning.

Keywords

Problem based learning, Medical triggers, Multimedia, Design and development, Medical education

Introduction

A new curriculum for students undertaking a degree in Medicine at the University of Melbourne began in semester one 1999. The detailed design of the new course, and the reasons behind the reform have been described previously (Keppell, Elliott & Harris, 1998). However, for the purpose of this paper the key features to highlight are the use of Problem Based Learning (PBL) and the incorporation of computer technologies, for teaching. The new course uses an Internet linked intranet system to deliver computer based teaching materials to students. Simulations of real life patient encounters are delivered to students on G3 or G4 Apple computers set up in each of the 34 PBL rooms and on the 46 G3 and iMac computers located in the Student Computer Resource Centre. The simulations take the form of problems of the week and are presented via a WWW browser along with other associated media such as X-rays, blood test forms and images. Multimedia teaching programs, experimental simulations, image banks, appropriate WWW sites and self-assessment tests are other learning resources that are presented on-line to students in these settings.

The use of computer technology to deliver problems of the week means that text can be enhanced with graphics, Shockwave movies and/or video. In this course, these media forms are used to produce a visual trigger that introduces students to the virtual patient and to some of the circumstances surrounding the hypothetical scenario. This paper describes the development processes that were formulated to produce visual triggers for the eighteen problems of the week used in the first year of teaching. It also reports on the effectiveness of these triggers to improve the quality of virtual patient encounters in the context of PBL.

Problem Based Learning (PBL)

At its most basic form, Albanese & Mitchell (1993) have described PBL as " an instructional method characterized by the use of patient problems as a context for students to learn problem-solving skills and acquire knowledge about the basic and clinical sciences" (p. 53). Unlike other problem orientated instruction methods (eg. case methods), PBL problems are presented to students before they have learned the basic science or clinical concepts (Albanese & Mitchell, 1993). The PBL process therefore involves the identification of learning needs by students following discussion of issues surrounding the problem and appropriate feedback by PBL tutors (Wilkerson & Feletti, 1989). Newly gained knowledge is then applied to the problem and the learning outcomes summarised (Barrows, 1985).

PBL problems generally mirror the complexity of real life and as such do not initially provide all the information needed to solve the problem. Problems that can not be solved by the understanding of a single concept or even a small number of concepts are known as ill-structured and are typical of real life medical problems. Although more information is required to understand the problem, there is no right or wrong way to obtain the information, and the acquisition of new information may change the problem (Koshmann, Kelson, Feltovich & Barrows, 1996).

The emphasis of PBL then is on self-directed learning; students both individually and as a group, are largely responsible for their own instruction and learning (Koshmann *et al.*, 1996). In this way PBL is seen as a collaborative style of instruction. Lectures, laboratory sessions and clinical skills sessions are not excluded but are used to supplement PBL. PBL is generally implemented with small groups of students (Vernon & Blake, 1993).

Albanese & Mitchell (1993) have reviewed the outcomes of PBL reported in the English language literature between 1972 and 1992. Compared to conventional instruction, three positive outcomes of PBL for students were identified. Generally PBL is more nurturing and enjoyable, PBL graduates perform as well, and sometimes better on clinical examinations and faculty evaluation, and PBL graduates are more likely to enter family medicine. Although space does not allow a detailed treatment of the theoretical foundations underpinning the PBL process, a summary is given by Keppell, Elliott & Harris (1998). For further explanation of the cognitive effects of PBL, readers are directed to Schmidt (1993).

The Use of Computer Technologies to Support PBL

Problems in a PBL medical course are usually structured around simulations of patient encounters. These can take the form of trained patient surrogates, otherwise known as 'standardised patients', or can be paper based (Koshmann *et al*., 1996). Virtual patient encounters presented to students on-line are an alternative type of patient encounter that are able to be enriched through the use of various media, including high quality graphics, Shockwave movies and video. As Schafe & Clarke (1997, p.2) point out in their study on the use of partially immersive virtual reality in tertiary education, "Virtual reality can be used to manipulate simulations

of the real world, without the danger, expense or time consumption of doing the real thing".

In the medical course at the University of Melbourne, PBL is used to complement traditional lectures and practical sessions. Patient simulations are presented to students on-line in the form of problems of the week. Each problem begins with a visual trigger that introduces students to a virtual patient and some of the circumstances surrounding the particular medical scenario being studied. Some introductory text appears underneath the trigger. The following computer screen instructs students to list what they have observed, "What are the patient's presenting problems?" then, for each problem a list is made of how it might be caused (hypotheses) and the rationale (mechanism) for each hypothesis. It is then up to each student to determine what further information they need to help them prioritise and decide between their different hypotheses. Such information could come from the virtual patient's medical history, physical examination or laboratory tests.

The progressive release of information throughout the week guides students in the evaluation of their hypotheses. In the course of a week students have on-line access to supporting information such as past medical history, results of physical examinations, patient's progress and investigation results. Students may also choose to explore the on-line resource list consisting of articles, book references, images/exhibits, posters, multimedia teaching programs and WWW sites. Students meet again with this additional knowledge to discuss the more plausible hypotheses behind the medical condition of the hypothetical patient. Finally at the end of the week, the final clinical impressions of the problem are made available, along with self-assessment items. The PBL sessions are held in small groups of about ten students under the guidance of a PBL trained tutor.

The Process of Development

As in any undertaking in which there are a large number of stakeholders (in this case medical, curriculum, educational, content, multimedia and IT delivery experts) it is often difficult to coordinate the conceptualisation, design, development and delivery of educational material to students. Communication between the various stakeholders is essential to avoid misconceptions and misunderstandings. Regular discussions were undertaken to avoid communication issues and also to provide stakeholders with an awareness of their role in the development process.

Throughout 1998 the content for each problem of the week was developed and written by teams of medical experts and academics under the guidance of the Faculty Education Unit (FEU). This unit was established within the Faculty of Medicine, Dentistry and Health Sciences to oversee the development and implementation of the new medical curriculum. It was, and continues to be staffed with both medical and curriculum development experts.

Translating expert knowledge

The first step towards the production of visual triggers for each problem of the week was to translate the expert knowledge obtained from the FEU into a format that could be utilised by non-medical experts such as multimedia designers, developers, photographers and videographers. A proforma of questions was created to aid in the transfer of this information. Figure 1 shows the proforma of questions used to translate information about a first semester problem entitled "Just checking". Although the information obtained from the proforma contributed greatly to the understanding by non-medical experts of the medical scenario/condition being depicted in the image, it was not always found to be adequate. A more accurate image could be produced if a medical expert was present during the photograph/video shoot to clarify unforeseen anomalies. This was particularly so if the photograph/video shoot took place in a hospital or ambulance where much of the setting and/or equipment was unfamiliar to the non-medical experts. This demonstrates the difficulty of capturing the tacit (or intuitive) knowledge of the medical expert.

Design

In their guide to the evaluation of multimedia applications for medical education, Atkins & O'Halloran (1995, p. 6) discuss the often "contrived, artificial nature of practice simulation", where a medical condition and/or scenario is presented to students as "too neat and tidy". This is in direct contrast to the complexity of real life patient encounters, which may include unusual presentations, and could involve missing or even erroneous data (Koshmann *et al*., 1996). The challenge therefore, of designing triggers for virtual patient simulations was to ensure that the image clearly demonstrated sufficient detail to enable students to begin the process of formulating hypotheses about the underlying medical condition, without compromising on the complexity of reality. A well-designed trigger could, for example, encourage the clinical-based reasoning skills of students. A poorly designed trigger, however, that made the medical condition too obvious, or alternatively distracted students with too much detail and caused the formulation of too many hypotheses, could inhibit this process.

Problem of the Week Trigger	
Problem	"Just checking"
Format	Photograph
Date	18/11/98 (2-5.00 pm)
Actors	Steve, Angela and Vicki
Costumes	Swimming bathers
Location	Williamstown Beach
Background Details	
1. What would you like the photograph/video to demonstrate?	1. A group of friends, one male and two females, sitting together on the beach in the sun.
2. What reaction would you like to see from students after they have viewed the photograph/video?	2. To set the scene for the medical condition which is a bad case of sunburn for the male. We would like the students to identify the fact that the group is enjoying themselves so much that they, in particular the male, forget about the effects of the sun.
3. Who is the main character in the photograph/video (gender, age, ethnic background, emotional state) and what is their role)?	3. A young male in his early twenties, very happy to be on the beach with his two female companions/admirers.
4. *What is the context/setting for the photograph/video shoot (hospital, ward or emergency department, ambulance, GP/specialist's surgery, home, other inside environment, outside environment)?*	4. A beach scene; the young people are sitting/lying on towels in the sand. The sea is in the background. They are not protected from the sun.
5. What props will be in the foreground?	5. Towels, beach bags
6. What props will be in the background?	6. Other people sitting on the beach in the background, the sea.
7. *Do any other people need to be in the photograph/video?*	7. Apart from the three friends there will be some people in the background.
8. Are weather conditions or the time of day important for this photograph/video?	8. It is a warm/hot summer's day.

Figure 1: Proforma of questions for a first semester problem entitled "Just checking".

Since the trigger represented the entry point of students to the virtual patient encounter, it also had the potential to influence student interaction with the problem by determining how realistic students rated the encounter. Our aim was to create triggers that could "suspend the disbelief" of students and allow them to approach each problem of the week as if it were a real life clinical case. The concept of "suspension of disbelief" is originally from theatre/literature but is now pervasive in the field of virtual reality. "Virtual reality is a state produced in a person's mind that can, to varying degrees, occupy the person's awareness in a way similar to that of real environments" (Macpherson & Keppell, 1998 p.63).

The medical content of each trigger needed to be matched "with the medium whose characteristics would best benefit that topic" (Koumi, 1994, p55). Information gleaned from the proforma (Figure 1) was also used to determine the most appropriate type of media (video, Shockwave movie, photograph) to use. For instance, a trigger that portrayed the medical condition *Myasthenia gravis* needed to show the progressive nature of the fatigue that occurs in skeletal muscle. Video was the media most capable of illustrating this progression over time. Other triggers that needed to demonstrate distinctive changes in a sequence were portrayed through a series of photographs using a Shockwave movie. In other triggers a single photograph was sufficient to convey the context and information necessary to begin the virtual patient encounter.

Production

After expert knowledge had been translated, the trigger design finalised, and the choice of media made, the next step in the development process was actual production. The characteristics of the trigger under production could be explained to professional videographers and photographers using the proforma of questions previously detailed (see Translating Expert Knowledge). In fact, the answers to these questions could easily be adapted to form the script for a video shoot or a brief for a photography shoot. Once the image for the trigger had been produced it was integrated into TopClass, the Web based software package that was used in this course to organise, coordinate, manage and deliver the teaching materials. An example of a problem of the week can be viewed at: http://www.medfac.unimelb.edu.au/Med/examplePOW/trigger.html

Evaluation

During semesters one and two in 1999, the visual triggers were delivered on-line to first year medical students. Preliminary evaluation was undertaken to elicit student response to the triggers, and to determine student modes of use.

A medical expert perspective

Following the completion of the first year of teaching in 1999, a semi-structured interview (Merriam, 1988) was conducted with the director of the FEU to gain an understanding of the interaction of students with the triggers. The director had participated as a tutor in PBL sessions held during semesters one and two, and had observed first hand the reaction of students to the triggers. The director had also played a major role in the conception, writing and design of the problems of the week (including the triggers). The first point raised during the interview was that the more authentic the trigger was, the more the students were drawn in by the reality of the situation and the more effective it was as a tool to initiate discussion about the scenario. From the eighteen triggers produced for first year, the trigger most preferred by students was real video footage of the Hawaiian Ironman Triathlon. Although the students did not know which triggers were images of real patients and which were staged, they seemed to prefer images of real patients. This may have reflected a student preference for triggers that were more clinically orientated or which reflected more acute medical situations. This is supported by the fact that students expressed great concern for a virtual patient who was experiencing severe pain, "How could they have taken photos of somebody in so much pain?" they asked. The point to highlight here is that the hospitalised patient was an actor, the scenario was staged and the students had been taken in by the reality of the image.

The positive reaction of students to the clinically orientated triggers was in contrast to triggers that depicted a consultation between doctor and patient in medical rooms. These triggers were considered by students to be boring, although it is not clear whether or not this inhibited their hypotheses making skills. Moreover, this type of trigger was unavoidable for a number of second semester problems where concepts such as tiredness and paleness need to be portrayed, concepts that are difficult to quantify. Age appropriate triggers were also found to be effective at initiating discussion amongst students. The trigger of the problem "Just checking" which dealt with a case of bad sunburn, depicted a 19 year old

man called Roger, sun bathing and flirting on the beach with two friends. This scenario initiated a detailed discussion about his behaviour and attitude. Although this example of a single image as an effective trigger was an exception, students generally preferred the use of video or Shockwave movies to a single graphic.

Students scanned the visual triggers to discover "what clues can we get from this". In the first semester problem "Is something wrong with me", video was used to depict a virtual patient suffering from *Myasthenia gravis*, hanging washing out on a line. Students noted that the woman was hanging up children's clothing and concluded correctly that she was a busy mother. This assumption was supported by the children's bike and balls placed in the background. In another trigger that portrayed an elderly woman lying on the floor of a lounge room, students noted that the light was on even though it was day-time and concluded correctly that the woman had been lying on the floor at least overnight. Students thought that the woman could have been the victim of an assault and subsequently searched for clues to support this hypothesis. In using the triggers students would scrutinise them "looking for the thing that didn't fit". Any inconsistencies between the trigger and introductory text were quickly spotted, particularly age differences, for example, the difference between a 22 year old virtual patient and the 26 year old actor playing the part. It was therefore critical that information such as the age and ethnic background of the actor playing the part was consistent with the virtual patient and with the name given to that patient.

A Student perspective

Following the interview with the medical expert, observations were made of students engaged in a genuine PBL session to determine how students reacted to, and interacted with the trigger. Considering the amount of information gleaned by students from the trigger (see A Medical Expert Perspective), it had been expected that they would initially spend a considerable length of time scrutinising the images/videos. Direct observation of students, however, revealed this wasn't the case. Rather, at the beginning of the PBL session students would quickly (almost casually) look at the trigger, taking note of the key features. They would then discuss the scenario in relation to the features they had previously identified. At this point students would revisit the trigger (again reasonably quickly) looking for information that would further refine their ideas. This process was repeated several times.

This mode of interaction was observed with the trigger used to commence the problem "Just checking". The trigger has been described previously in Section 4.1 and depicts the virtual patient Roger sunbathing with friends on a beach. The key features initially noted by students were that Roger "was young (19)", that "he's pretty fit (and) has a good body" and that he was "trying to get a tan". The identification of these characteristics was quickly refined to include "He seems to care about his looks". Further discussion was initiated about his attitude including his "risk taking behaviour" and the probability that "he will go out and repeat (the behaviour)". At this point the trigger was revisited and additional features about Roger were noted such as his pale, fair skin and the presence of numerous moles and freckles. These observations led to discussions about skin pigment, UV damage to skin and finally cancer. Students used the trigger repeatedly, in short bursts, to extract information necessary to begin the process of hypothesis formulation. It appears that each time students revisited the trigger they used the new set of data to further elaborate and enhance their interpretation of the medical scenario. It was not unexpected to find that students obtained the more obvious (or simple) details from the trigger first, extracting more complex details over time.

Future Directions

The importance of the triggers in influencing the way students interacted with a problem justified the emphasis placed on design. Preliminary evaluation highlighted the need for triggers that were as realistic as possible within the production constraints of time and cost. Incorporating information into the trigger that improved its authenticity and was noted by students, but was not directly related to the medical condition, meant that problems were not "neat and tidy" but were a more realistic representation of ill-structured material. Authentic triggers were capable of immersing students in the problem, and of creating a mind set that allowed students to approach the problem as if it were a real life clinical situation.

Observation of students engaged in problems of the week demonstrated how carefully students scrutinised the visual triggers looking for cues to begin the formulation of hypotheses. It was therefore critical that the visual images were consistent, and that they matched any textual information given. Discrepancies of this nature decreased the authenticity of the virtual patient encounter and minimised its impact on students. Preliminary evaluation also indicated that the use of graphics, Shockwave

movies and video to enhance on-line patient encounters afforded a greater degree of student interactivity with the problem than what was possible through print alone. However, further detailed evaluation will need to be undertaken to determine the consistency of match between the conception of the designers and the actual interpretation by the student. An analysis of this type would enable a comparison to be made between the mental models of designers and the student learner.

This study outlines the responses of first year students to the triggers of the eighteen problems of the week used throughout semesters one and two. As students progress into their second year of the course and become more proficient at the PBL style of learning, the design of the triggers will become increasingly important. Authentic triggers will be required that really get students thinking about a medical scenario. There will also be a need to introduce more variation into the format of the triggers to avoid repetition.

Finally, Albion & Gibson (1998, p. 40) acknowledge in their paper describing the design of multimedia materials in the context of PBL that "There is a pressing need to ensure that the materials being developed and delivered incorporate effective instructional methods". In establishing a development process for the production of the eighteen visual triggers used in semesters one and two, it was hoped to maintain the instructional standard for design and development of the further 140 visual triggers, needed to be produced for semesters three to five of the course.

References

Albanese, M. A., & Mitchell, S. (1993). Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine*, 68(1), 52-81.

Albion, P. R., & Gibson, I. W. (1998). Designing multimedia material using a problem-based learning design. In R. M. Corderoy (Ed), *Australian Society for Computers in Learning in Tertiary Education. Ascilite'98 Conference Proceedings*, University of Wollongong, NSW., 39-47.

Atkins, M. J., & O'Halloran, C. (1995). Evaluating multimedia applications for medical education. *AMEE Education Guide* No.6, 1-10.

Barrows, H. S. (1985). *How to Design a Problem-based Curriculum for the Preclinical Years.* New York: Springer Publishing Company.

Keppell, M., Elliott, K., & Harris, P. (1998). Problem based learning and multimedia: Innovation for improved learning of medical concepts. In R. M. Corderoy (Ed), *Australian Society for Computers in Learning in Tertiary Education. Ascilite'98 Conference Proceedings,* University of Wollongong, NSW., 417-424.

Koshmann, T., Kelson, A. C., Feltovich, P. J., & Barrows, H. S. (1996). Computer-supported problem-based learning: A principled approach to the use of computers in collaborative learning. In T. Koshmann (Ed), *Computer Supported Collaborative Learning: Theory and Practice in an Emergency Paradigm*. Mahwah, NJ: Lawrence Earlbaum, 83-124.

Koumi, J. (1994). Media comparison and deployment: A practitioner's view. *British Journal of Educational Technology*, 25(1), 41-57.

Macpherson, C., & Keppell, M. (1998). Virtual Reality: What is the state of play in education? *Australian Journal of Educational Technology*, 14(1), 60-74.

Merriam, S. B. (1988). *Case Study Research in Education: A Qualitative Approach.* San Francisco: Jossey-Bass Inc.

Schafe, L. M., & Clarke, R. J. (1997). Tertiary educational uses of partially immersive virtual reality. In R. Kevill, R. Oliver and R. Phillips (Eds), *Australian Society for Computers in Learning in Tertiary Education. Ascilite'97 Conference Proceedings*, Curtin University of Technology, Western Australia5, 538-543.

Schmidt, H. G. (1993). Foundations of problem-based learning: Some explanatory notes. *Medical Education*, 27, 422-432.

Vernon, D. T. A., & Blake, R.L. (1993). Does problem-based learning work? A meta-analysis of evaluative research. *Academic Medicine*, 68(7), 550-563.

Wilkerson, L., & Feletti, G. (1989). Problem-based learning: One approach to increasing student participation. In A. F. Lucas (Ed), *The Department Chairperson's Role in Enhancing College Teaching*, New Directions for Teaching and Learning, San Francisco: Jossey-Bass Inc., 37, 51-60.

Acknowledgments

The authors wish to thank Associate Professor Susan Elliott director of the FEU, for her time and valuable comments made during the medical expert interview.