

# Using Computer Technology to Enhance Problem-Based Learning

[Kristine Elliott](#)

*Faculty IT Unit, Faculty of Medicine, Dentistry and Health Sciences, The University of Melbourne, Australia*

and

[Mike Keppell](#)

*Biomedical Multimedia Unit, Faculty of Medicine, Dentistry and Health Sciences, The University of Melbourne, Australia*

## Abstract

The focus of this paper is on how computer technology can be used to enhance the effectiveness of clinical problems in a problem-based medical curriculum. Visual/audio triggers are being used in the medical course at The University of Melbourne to set the stage for clinical problems by introducing students to a virtual patient, and to some of the circumstances surrounding the hypothetical situation. Digitised photographs, *Shockwave* movies, digitised video segments or a combination of these media types act as entry portals into the on-line "problems of the week". In designing the triggers our aim was to create authentic images that would "suspend the disbelief" of students and allow them to approach each problem as if it were a real life clinical scenario.

## A problem-based medical curriculum

A new medical curriculum combining problem-based learning (PBL), self-directed learning (SDL) and computer-based educational technology was introduced at The University of Melbourne in 1999 (Keppell, Elliott and Harris 1998). This change represented a fundamental shift in the philosophy of teaching by the School of Medicine. Traditionally, medicine had been taught using a discipline-based approach with students learning the basic sciences (anatomy, biochemistry, microbiology, pathology, pharmacology and physiology) as discrete subject blocks in the first three years of their course. This knowledge was then applied to clinical sciences in latter years.

The focus of the new PBL curriculum is on providing an integrated approach to teaching. Horizontal integration across disciplines helps students to relate knowledge between various subjects, and vertical integration of basic sciences with clinical situations exposes students to clinical situations from semester one. This approach also encourages students to relate knowledge across different years of the course. Issues concerning the human mind and behaviour, and health and society are integrated throughout the entire curriculum.

The instrument used to implement the integrated course is clinical problems written around the major systems of body function (body systems). Each week, small groups of students in tutorial settings are presented with an on-line "problem of the week"

<http://www.medfac.unimelb.edu.au/Med/examplePOW/trigger.html>. Each problem begins with a trigger that introduces students to a virtual patient and to some of the circumstances surrounding the clinical scenario. Students list what they have observed, "What are the patient's presenting problems?" and any possible causes (hypotheses). Through group discussion and tutor facilitation (if necessary) the rationale or mechanism of each hypothesis is also considered. Students then decide both individually and as a group, what further information they need to help them prioritise and decide between their hypotheses.

The progressive release of additional information throughout the week guides students in the evaluation of their hypotheses. Students have on-line access to supporting information such as past medical history, results of physical examinations, patient's progress and investigation results/laboratory tests. Students may also choose to explore the on-line resource list consisting of articles, book references, images/exhibits, posters, multimedia teaching packages and web sites. Following this period of self-directed learning, students meet to discuss the more plausible hypotheses behind the medical condition of the hypothetical patient. At the week's end, final clinical impressions of the problem are made available to enable students to compare their own diagnosis and followup, to one made by an expert.

## **Computer technology to support PBL**

One of the advantages of presenting clinical problems on-line is the capacity to enrich them with high quality graphics, *Shockwave* movies and video (See <http://www.medfac.unimelb.edu.au/dev/kelliott/fig2.gif> to view how computer technology is used in the new medical curriculum). In the medical course at The University of Melbourne, multimedia triggers are being used to set the stage for clinical problems by introducing students to the presenting patient, and to some of the circumstances surrounding the hypothetical medical situation. Our aim in designing these triggers 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. Since the trigger represented the entry point to the problem, it could potentially influence student interaction with the problem by determining how realistic students rated the encounter. An example can be found at <http://www.medfac.unimelb.edu.au/dev/keppell/106small.dcr>.

In their guide to the evaluation of multimedia applications for medical education, Atkins and 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 (Koschmann et al. 1996). The challenge of designing triggers for clinical problems was to ensure that the images 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. An example can be found at <http://www.medfac.unimelb.edu.au/dev/keppell/trigger.jpg>.

## Evaluation

### 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 Faculty Education Unit 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. Of 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 photographs 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.

In using the triggers students would scrutinise them "looking for the thing that didn't fit". 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 daytime 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.

### 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 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**

Evaluation highlighted the need for triggers that were as realistic as possible. 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 triggers looking for cues to begin the formulation of hypotheses. It was therefore critical that the triggers were consistent, and that they matched any textual information given. Discrepancies of this nature decreased the authenticity of the clinical encounter and minimised its impact on students.

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.

## References

1. Atkins, M. J. and O'Halloran, C. (1995) Evaluating multimedia applications for medical education. *AMEE Education Guide* No. 6.
2. Keppell, M., Elliott, K. and Harris, P. (1998) Problem based learning and multimedia: innovation for improved learning of medical concepts. In R. M. Corderoy (Ed), *Australasian Society for Computers in Learning in Tertiary Education. ASCILITE'98 Conference Proceedings*. (417-424). University of Wollongong NSW.
3. Koschmann, T., Kelson, A. C., Feltovich, P. J. and Barrows, H. S. (1996) Computer-supported problem-based learning: a principled approach to the use of computers in collaborative learning. In T. Koschmann (Ed), *Computer Supported Collaborative Learning: theory and practice in an emergency paradigm* (83-124). Mahwah, N. J., Lawrence Earlbaum.
4. Merriam, S. B. (1988) *Case Study Research in Education: A Qualitative Approach*. Jossey-Bass Inc., San Francisco.

Kristine Elliott  
Faculty IT Unit  
Faculty of Medicine, Dentistry and Health Sciences  
The University of Melbourne  
Australia  
[kaelli@unimelb.edu.au](mailto:kaelli@unimelb.edu.au)

Mike Keppell  
Biomedical Multimedia Unit  
Faculty of Medicine, Dentistry and Health Sciences  
The University of Melbourne  
Australia  
[mkeppell@unimelb.edu.au](mailto:mkeppell@unimelb.edu.au)

---