Utilizing Case-Based Reasoning and Multimedia to Enhance Clinical Decision Making of Novice Practitioners: Product Implementation and Evaluation

Mary Oliver
Department of Nursing
The University of Southern Queensland, AUSTRALIA
Oliver@usq.edu.au

Som Naidu
Multimedia Education Unit
The University of Melbourne, AUSTRALIA
s.naidu@meu.unimelb.edu.au

Andy Koronios
The University of Southern Queensland, AUSTRALIA
Koronios@usq.edu.au

Abstract

This paper describes the outcomes of a self-paced multimedia learning environment designed to enhance critical thinking skills in clinical decision making of graduate nurses entering the workforce. The multimedia-learning environment represents a contrived situation that simulates the complexities of life in a typical hospital ward, which places the users in the role of problem-solvers. Problem solving in the simulation is based on a rich repository of cases and stories that have been extracted from the experiences of expert practitioners. This case-based reasoning architecture reflects a model of learning where users are coached in the development of decision-making skills within the context of a contrived but an authentic presenting problem. Users engage in critical thinking and decision making after accessing the experiences and expert stories of practitioners, which are presented in the form of audio/video clips on the CD-ROM. The formative evaluation of the learning environment, with embedded activities involved

structured and open ended question types with individual and small groups of practicing nurses and subject matter experts. A semi-structured questionnaire was employed to ascertain user perceptions and this enabled us to evaluate the utility and the efficacy of the product from the perspective of graduates. The results show a very high user acceptance of this learning environment and the approach to learning.

Introduction

This paper is based on the implementation and evaluation of an interactive multimedia-learning environment designed to enable graduate nurses to utilise critical thinking skills when making clinical decisions at the workplace. In this learning environment, we sought to present critical aspects of workplace-related issues embedded in an interactive multimedia format for use by graduate nurses and final year nursing students to become 'work ready' in preparation to enter the workforce. The environment used authentic cases to simulate the complexities of life in a typical hospital ward, and placed graduating nurses in the role of decision-makers and problem-solvers. Problem solving in the simulation was based on a rich repertoire of cases and stories that had been extracted from the experiences of expert practitioners. This case-based reasoning architecture reflects a model of learning where graduating nurses were coached in the development of diagnostic reasoning and decision-making skills within the context of a contrived but an authentic scenario with a presenting problem. The material was presented on CD-ROM, which simulated the complexities of life during a life-threatening emergency in a typical hospital ward, and in so doing made the education of graduate nurses and students case-based and authentic.

Learning activities incorporated in the courseware required users to make decisions about the best course of action, and source of information regarding each case or problem that was presented. Users were also able to discuss the cases presented to them in the multimedia environment and reflect on how they might have addressed the situation. This learning architecture reflects a situated cognitive model of learning where students and graduating nurses are coached in the development of their strategies for recognising learning opportunities and critical thinking with the help of authentic cases.

Critical Thinking and Problem Solving

How could learners gain skills in critical thinking and problem solving while engaged in decision-making? It is evident that the most effective method of instructing clinical decision-making and problem solving is through experiential learning where learners have the opportunity to engage in critical thinking. Critical thinking is integral to clinical judgment making and is frequently associated with diagnostic reasoning. Critical thinking is considered to improve diagnostic skills (Brooks & Shepherd, 1990); (Miller, 1992) and more recently in nursing, critical thinking has come to be regarded as an all-important skill which is necessary for decision making in clinical practice. Described as thinking about thinking (Kuhar, 1998), critical thinking is a metacognitive activity that involves recognising a problem and using a cognitive process for problem solving. Nearly four decades ago Dewey viewed critical thinking as simply intelligent action and proffered "…by putting the consequences of different ways and lines of action before the mind it enables us to know what we are about when we act. It converts action that is merely appetitive, blind and impulsive into intelligent action" (Dewey, 1964, p.212).

Critical thinking is inextricably linked to problem solving in the real world of practice and research in critical thinking has studied how physicians, pharmacists, educators, management professionals, and nurses use critical thinking in problem solving (Berczller, 1996); (Kane, L., & Hamilton, 1995); (Paul, 1992); (Brookfield, 1987); (Howenstein, Bilodeau, Brogna, & Good, 1998); (Whiteside, 1997); (O'Neill, 1997). Researchers have linked critical thinking ability and decision making skills to cognitive skills (Brooks & Shepherd, 1990). Viewed as a rational, disciplined and self-directed thinking process applied to human concern or domain of knowledge (Paul 1992) is particularly useful for the clinical practice of nurses. This implies that nurses who possess these attributes can function competently in complex health care settings. Some regard critical thinking as "the new educational paradigm" (Whiteside, 1997) and panacea for all ills. Others regard critical thinking as a mindset or a way of thinking (Kyzer, 1996,p.3) rather than a method or a set of steps to follow. What is evident is that critical thinking is a way of thinking that is based on fundamental intellectual standards and values. Skills such as clarity, accuracy and precision of thought, relevance, depth and breadth of thought are sub-skills, which lead to creative problem solving in critical thinking.

Consider for example the potency of such skills when they are integrated and taught in conjunction with clinical reasoning and problem solving in practice. This has been our ethos underpinning the development of this case-based reasoning learning environment. We have not recommended throwing out all the textbooks and abandoning students in a welter of diverse information sources presented in this multimedia environment. On the contrary, we suggested leading students very carefully through unstructured problem situations from multiple perspectives and sources of information, providing careful instructional feedback, not only on content mastery but also on the skills of information-processing, critical thinking, and clinical decision-making.

Case-based Reasoning Architecture

Developing a self-paced multimedia-learning environment designed to facilitate the transition of graduating nurses into the workplace, the environment used an authentic case to simulate the complexities of life in a typical hospital ward, and placed-graduating nurses in the role of decision-makers and problem-solvers. Problem solving in the simulation was based on a rich repertoire of cases and stories that had been extracted from the experiences of expert practitioners. This case-based reasoning architecture reflected a model of learning where graduating nurses were coached in the development of critical thinking and decision-making skills within the context of a contrived but an authentic scenario with a presenting problem. A patient experiencing an anaphylactic reaction was used as the precipitating event to engage users in diagnostic reasoning, making critical decisions. An anaphylactic reaction has the potential to cause a chain of events but as a contrived learning situation, users within this learning environment were not constrained by the pressure of time and they could make mistakes if necessary, without causing injury to patients. This is important if users are to gain competence in making critical decisions in life threatening situations. Support for users was given in the form of feedback and rationales were provided for each decision that was made. Users also had the opportunity to review relevant documents and consult the experts when making decisions. Making mistakes and learning from experience was one of the goals of this environment, which is not obviously possible in real life threatening situations.

This seemingly clear-cut contrast is a radical shift in approach to this component of undergraduate nursing education. A shift which combines powerful educational technologies and proven learning strategies to build

a technology enhanced learning environment. This environment is innovative in two ways. First, it integrates powerful technology with problem-based learning and case based reasoning in an integrated learning environment. Second, it places users as decision-makers within the simulated learning environment. The model of learning, that guided the development of the learning transaction, and which integrates problem-based learning and case based reasoning (Naidu, Oliver, & Koronios, 1999) is illustrated in Figure 1.

- Learners encounter cases/problem situations as they enter the learning environment.
- They explore cases/problems at two "case conferences" in the multimedia environment.
- Their goal in this environment is to develop an action plan for managing the patient situation.

Phase I: Case encounter

- Learners encounter the case at *handover* where they are explained its history and pathology.
- Their *goal* in the simulation is to develop an action plan for managing the situation in the given case.
- Their success is measured by reports they receive from their supervisors and peers.

Phase II: Reflecting at case conference I		
Becoming aware	**Seeking solutions**	**Making decisions**
Learners listen to the stories and experiences of expert practitioners.	They ask experts questions about their work experiences.	Learners develop a tentative action plan for feedback from supervisors.
Phase III: Reflecting at case conference II		
Raising issues	**Seeking solutions**	**Making decisions**
Learners explore new and related issues to the problem by reviewing sources of information.	They ask experts additional questions about their work experiences.	Learners develop their final action plan to submit to their supervisors to receive feedback.
Phase IV: Developing an action plan		
In this phase learners have their action plans accepted by supervisors and receive feedback on their decision-making.		

Figure 1: Technology Enhanced Case-Based Reasoning

Within this multimedia simulation, users were required to engage in activities and work towards their ultimate goal, which was the successful management of the presenting problem (managing a patient experiencing anaphylaxis). These activities comprised of selecting decision options, and by dragging and dropping them in appropriate boxes, users could choose to administer a particular treatment, decide to summon help, or opt out to consult expert video clips for advisement in making appropriate and timely decisions. Additional resources other than expert's stories, such as policies and procedures, reference manuals were also made available to users.

The Simulation Environment

Users begin the program by reviewing the clinical case of a patient experiencing an anaphylactic reaction within a hospital ward environment. A guide is used to welcome users and inform them of their immediate goal. In this scenario learners are required to make clinical decisions on the basis of information that is made available to them. This information was presented in the form of documentation and expert knowledge (which are encapsulated as stories) to manage a crisis situation. Users begin by attending a *handover*, which is a regular event of a nurse's daily routine where relieving nurses are updated on the current situation of their patients and this is where the user encounters the case. As in a real hospital setting after *handover* the user attended to routine ward activities before being confronted with the "precipitating event".

Using an emergency situation as the precipitating event, with the potential to cause a chain of events in this instance, the simulation requires the learner to make complex decisions under the pressure of time. Within this learning environment though, time was not a variable because this is a contrived learning situation in which users have the opportunity to review relevant documentation and seek advice from experts if necessary on the best practice before making decisions. Decision making to avert the crisis situation is the goal or mission of the user. In order to achieve this goal or mission, the first thing the user must do is to understand the situation and deal with it because the situation has the potential to deteriorate, and then develop an appropriate decision plan to manage the situation. In order to do this, it was necessary that learners *understand* the crisis, including its causes and implications. This is where the activities comprising of decision options become useful to users because in this environment they have the opportunity to review the patient's medical history, presenting pathology and make a diagnosis before selecting the appropriate treatment modalities. Consider for example having the opportunity to summon for help, administer drug therapy, and consult expert opinion for advisement, before making appropriate and timely decisions and being prompted by way of rationales for decisions taken. The simulation provides potent feedback on the decision skills of the user.

Users are encouraged to make these decisions after having listened to the experiences of expert practitioners. These experiences (reported as vignettes) were presented in the form of stories and made available to users as they make their decisions. *This is where the learning was taking place for the individual.* In real life, nurses do not have the time in a crisis

situation to seek information because of the pressure of time associated with the situation. In this context however, they are given the opportunity to reflect upon each action, and seek advice and information, and review resources before including them as part of their decision plan.

Finally, users are in a position to develop a decision plan that is based on informed decision-making and one that is realistic. They achieve this by learning from the experiences of expert practitioners. The architecture of the model is designed to develop in learner's clinical decision-making skills. Its expressed intent is to expose beginning registered nurses to the process of diagnostic reasoning and clinical decision-making. Ultimately, within this case-based reasoning environment and through the use of critical thinking users can gain competence in making clinical judgments during life-threatening situations.

Industry Collaboration

The development of such a product could only be useful when it were developed in collaboration with industry partnerships. Such support is vital to the success of a product such as this because new graduates are not "finished products". The educational process must extend to the workplace and provide the skills and knowledge upon which the novice can develop an experiential knowledge base. The case–based reasoning architecture which we have employed in this product is poised to do just that, because it brings together expert stories and experiences of expert clinicians and this information is made available to the new graduates within this learning environment. This product has undergone a series of iterations of progressive development. We have worked very closely with the nursing division at St Vincent's Hospital to create this learning environment containing both generic content about the diagnosis and management of anaphylaxis as well as procedures and protocols that are specific to St Vincent's Hospital, which served as the reference site for the project. Moreover, to achieve the most realistic nursing clinical decision making environment possible, all participants in the video clips used in this multimedia courseware are clinical nurses who volunteered their time.

Evaluation

Formative and summative evaluation of the product was carried out with the help a semi-structured questionnaire. The main focus of this exercise was to ascertain user perceptions of their use of the product. Results of the formative evaluation carried out show that users find the learning program easy to use and navigate. The majority did not find the information overwhelming, and felt that the content was pitched at an appropriate level for the target group. With regards to interface design users felt that the screen design was pleasing, appropriate use of graphics had been made, and that the clarity of information presentation was high. On the whole users surveyed found the program enjoyable. Subjects were asked how *interesting* they found the material on each one of the sections on the CD. Material on the CD was itemised to include: Handover, attending to patient, listening to stories, making decisions, and preparing the report. The majority found each one of these sections as either interesting or very interesting. Subjects were also asked to rate the *usefulness* to them of these same attributes. All of them rated these attributes either useful or very useful. In summary, what did they like most about the multimedia-based simulation? These included simple access to different components, more

interesting information, and better retention in comparison with reading a journal article or book, realistic presentation, interactive patient observation.

The following are the results of the summative evaluation carried out by beginning practitioners on completion of the program at their workplace. All of these participants had undertaken an introductory course in computing during the course of their undergraduate study.

Sample

A total of 20 registered nurses with prior experience in the use of computer-based technologies completed this evaluation exercise. Most claimed to be very comfortable with the use of computers.

"Use" of the Program

No one experienced any major problems with the use of the CD. Most also found it easy to navigate. The majority of the users spent 30-60 minutes going through the full program with some of them spending as much as 90 minutes on it. The accompanying User's Manual was found to be very helpful

"Content of the Program"

We wanted to find out how interesting the following aspects of the simulation were. Most users seemed to have found much of the program interesting except preparing the report!

	Very interesting	Interesting	Uninteresting
Handover	5	17	3
Attending to Patient	10	14	1
Listening to Stories	11	12	2
Making Decisions	8	13	2
Preparing Report	5	13	6

Clearly, many found the program components useful.

	Very useful	Useful	Not useful
Handover	9	13	2
Attending to	10	13	1

Patient			
Listening to Stories	4	18	2
Making Decisions	6	16	1
Preparing Report	2	19	1

"Look and feel" of the Program

On the whole users suggested that they found the program easy to use, easy to navigate and with balanced supply of information. Many found the *Overview* facility in the program, useful, and the *Screen design* pleasing. They also reported finding *Information presentation* clear.

> "I liked the problem-based approach. The reference section is great. It would be good if "texts" were available to the user, which contained some background information on why the CD was developed, why the subject and content is important to the user. Not too many whiz-bang effects. Nice balance."

Users found the program on the whole very functional, although, some thought that there were some inconsistencies in the story line. Aesthetically, users found the program very pleasing. Likeable *features* of the program included:

- Simple access to different components.
- More interesting and retained information than if reading a journal/book or article.
- Realistic presentation.
- Interactive patient observation.
- "Hyperlink" possibilities.
- Realistic.
- Ability to go back and review
- Ease of use
- Presentation of information using various formats such as play-acting, experts describing scenarios and descriptive summaries were excellent. The acting was very real and interesting
- Use of bedside nurses experiences. Follow up questions and resources available screen
- Realistic beside scenes
- Resources
- The ease of use

- Video – real life Aesthetics
- Easy to get around on Interactive
- Interaction with patient makes it realistic
- Realistic
- Develop theories based on visible symptoms to manage
- Ease of use
- Attention to detail
- Interviews with clinical nurse in setting
- Detailed information (excellent resources material) for treatment of anaphylaxis results and drug information
- User friendliness – good prompts – choices
- Quality of information
- Sequencing of information/ interactive ability

Following are some of the qualitative statements that were offered by users of the program.

"Going to the patient's bedside was very interesting and exciting for me. Having a guide available to give directions if unsure was excellent" Peggy.

"I believe I have learned a lot more about anaphylactic reactions and now think I could handle a situation more comfortably and appropriately if it presented itself. I wish we had more of these CD-ROM packages addressing other issues" Leah.

"I enjoyed the case studies and often if you can relate to a situation you can learn from it. I enjoyed the RN who compared IV pushes to inserting an antibiotic through a burette. I had never considered these features before however I now know that to make an appropriate clinical decision, you need to have a high knowledge of the disease/illness pathology, presenting signs and symptoms and interventions. You also need to have a good understanding of your patient gained through handover, patient's notes and good communication. I enjoyed the CD-learned a lot of useful things that I will take with me in my career" Seth.

" For me, the information cue to *revisit anytime* was one of the best features of this program. The visual practice based information combined with the theory was very helpful. I have nursed for the past 17 years (although not as a RN) and never seen an acute anaphylactic reaction, but now I have and know what to do in this situation. The subtle prompting in communication with the doctor and to have a clear understanding of the situation were important issues that I picked up from this program" Cheryl.

"I liked the features of verbal communication. The information presented was very relevant, clear and important. The program was about real people and real experiences. I have leaned the importance of open communication with staff and always to be prepared for the worst possible scenario, to use knowledge based on common sense and to decide in an orderly fashion that is based on theory" Fiona.

Conclusions

In conclusion, graduates are not finished products and the education process must extend to the workplace and is best achieved through industry collaboration. By incorporating critical aspects of workplace related education on a multimedia CD-ROM, we were able to ascertain the user perceptions of the product from graduate nurses who have recently entered the workforce. Such a learning environment apart from innovative is necessary, because it integrates case-based reasoning architecture in the design of interactive multimedia-based materials for graduate nurses, which has previously not been attempted. The significance of this innovation to nursing is that it complements the existing support programs such as Preceptor and Graduate Nurse Programs put in place for enhancing the transition of new graduates to the workforce. The just in time learning that the program offers stands to assist in reducing the high stress levels of new graduates through the experiences of expert practitioners. The expert experiences are provided in the form of vignettes to support the decision making process of novice nurses.

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