Radiography (2006) **12**, 244–252

ELSEVIER

THE SOCIETY AND COLLEGE OF RADIOGRAPHERS

E-learning in an undergraduate radiography programme: Example of an interactive website

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Received 25 August 2004; accepted 17 May 2005
Available online 1 July 2005

KEYWORDS
Online learning;
Undergraduate;
CE/CPD;
Internet;
WebCT

Abstract **Purpose** To demonstrate how e-learning can be integrated into an undergraduate radiography programme, using an academic subject dealing with ethico-legal issues as an example. Information provided could be applied to any form of online learning.
Methods One academic subject from an undergraduate radiography programme, Case-Based Learning for Professional Studies, which had previously been taught using traditional face-to-face methods, was transformed into an e-learning format. Students who experienced the new e-learning format were evaluated by means of an online evaluation questionnaire.
Results Eighty-three percentage of respondents felt confident/semi-confident about participating in online *Chat* sessions. Around 34% of respondents thought that the *Discussion Board* was useful for communicating with fellow students. Nearly 70% of respondents believed that access to online materials enabled them to prepare for lectures and tutorials. However, 34% of students preferred more face-to-face lectures/tutorials. Overall, feedback was positive.
Conclusion Course providers and other relevant stakeholders need to be proactive in determining ways to facilitate undergraduate and post-registration development and learning. E-learning can be utilized to benefit learners who wish to work at their own pace and who cannot attend courses at remote sites. Individuals can reap the benefits of an online learning format and affording learners more flexibility and providing guidance for them, by means of a website, may help to promote a positive attitude to lifelong learning.

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1078-8174/$ - see front matter
doi:10.1016/j.radi.2005.05.009

Introduction

E-learning has been the subject of many journal articles, discussions and seminars since 2000, a year which, amongst other things, has been nicknamed ''E-learning Year Zero''.[1] Although computer-aided instruction has been around since the 1980s, it was not until the World Wide Web (WWW) became widespread in the 1990s that IT-based learning and subsequently e-learning became increasingly popular amongst the general public. Since then, the e-learning market has been expanding and is predicted to grow significantly over the coming years.[2] According to studies conducted by Giga Information Group, universities and colleges in all countries expect to increase their e-learning expenses from US$ 2.0 billion in 2001 to US$ 15.0 billion in 2005.[3] Eduventures Inc., a Boston-based research firm, has published a report which predicts that the total enrolment in United States (U.S.) online education programmes will hit one million by 2005.[4] The fundamental value proposition of e-learning is the access to quality education without the constraints of time and location. Consider the following scenario:

''Things are quiet at work right now, so I'm using my PC to access the course materials on the web. I choose an item from the training menu, and put in a bit of private study. When there's something I don't understand, I e-mail a query to the tutor, and the reply comes back within 24 h. If I fall behind with my coursework, I get a warning by e-mail...''[1]

Consequently, e-learning holds the promise of educational opportunity for vast audiences of learners across the globe.

The Hong Kong Polytechnic University (PolyU) has invested heavily in the web-enabling of learning contents of academic subjects from their traditional mode of instructor-led, face-to-face delivery to an online mode of delivery. In the Department of Optometry and Radiography, a large number of subjects now contain interactive e-learning components presented through WebCT, the university virtual learning environment (VLE). WebCT is a user-friendly course development tool which enables teachers and students to build and use web-based course content. It provides the essential functions of interactive teaching/learning through the Internet, including online bulletin board and chat rooms, interactive quizzes, internal mail, class calendar, class management and performance tracking. By using this 'shell' approach, an instructor can build up a course site for any academic subject with different types of learning materials and can use a range of built-in tools to assist with the management and assessment of the academic subject.[5] The eight universities in Hong Kong have used the commercial web-based software programmes, such as WebCT, since 1997. The primary motivation for developing or adopting them is to allow instructors who have little knowledge of Internet technologies and HTML to put course materials on the web with minimal effort.[6]

Therefore, the purpose of this paper is to provide an insight into how e-learning can be integrated into an undergraduate radiography programme, using one academic subject as a specific example. Although the focus of this article will be on undergraduate radiography education, information provided may be equally applicable and relevant to any form of online learning, so could be adapted for Continuing Education (CE) or Continuing Professional Development (CPD) programmes. In this regard, it is suggested that the e-learning format could facilitate the learning process and overcome some of the limitations which currently exist for the part-time, professional learner.

Student learning in the undergraduate radiography programme at the PolyU has traditionally followed the face-to-face approach. However, face-to-face learning for students may not always best utilize their time and it has been suggested that some home-study or off-campus learning may be a viable alternative. Students could then study at a time and place convenient to them, without the need to travel to the PolyU campus. In fact, some websites flag the advantages of learning in this way and one of the most common methods of completing a distance education course/subject is to buy a book, read it, and sit an online exam, such as the ones provided by the JPC Foundation (http://www.jpcfoundation.org/). Another way is through the viewing of movies and web-casts, such as the ones provided by the Philips Online Learning Centre (http://www.theonlinelearningcenter.com/catalog/default.aspx). This second option is a lot more exciting than merely reading texts, but still lacks that interactive component which makes learning an interesting experience. The best solution or compromise may be to build an e-learning system which includes a virtual laboratory for radiography professionals.

The concept of a virtual laboratory is not new. The idea is to have an interactive real-time simulated laboratory which students can access anywhere, anytime to practice their skills. The Virtual Lab of Engineering Mechanics (VLEM) developed by

Tsinghua University is one such example.[7] It is used by Mechanical Engineering students to practice the experiments of engineering mechanics, without the need to have actual access to equipment. One can even take this concept further, and interface the laboratory equipment with computers so that students operate equipment, in turns, and perform remote-controlled, online experiments in real time.[8] This can be achieved with a combination of hardware and software devices available from vendors like National Instruments Corporation and The MathWorks, Inc. These are just some of the advantages of having an e-learning environment for students to explore. This article will go on to offer access to one site created by the authors and enable the readers of this article to experience an e-learning facility for themselves.

Methods

The authors have been involved with the online development of two radiography academic subjects, namely Health Care Studies, which relates to patient care issues, and Case-based Learning for Professional Studies in Healthcare, which covers ethico-legal and professional issues. In this respect, case-based learning ensures that the teaching is active and is built upon the learner's prior experiences and knowledge. Consequently, cases are used to activate student learning.[9]

''A teaching case is a story, described or based on actual events and circumstances, that is told with a definite teaching purpose in mind and that rewards careful study and analysis. The case method of teaching is a set of pedagogical techniques and 'tricks of the trade' that instructors use in the classroom to help learners reach specific learning objectives with the teaching case as a basis for discussion. In the real world, the solutions to complex problems cannot be found in textbooks, nor will everyone agree on the 'right answers' to difficult questions. The case method prepares learners for a world that demands critical thinking skills and the ability to create convincing arguments, often with little time and incomplete information.''[10]

For the purpose of this paper, the authors share their experiences of implementing one academic subject in an online format. Prior to 2003/04, this subject was taught by means of the traditional mode of face-to-face lectures and tutorials. Final year students on the BSc. (Honours) Radiography programme intensively study this academic subject for the first seven weeks of a 14-week semester. They then attend clinical placements in public hospitals for the next six weeks, before returning to the PolyU campus for the final week of the semester. This paper will describe how an online academic subject, 'Case-based Learning for Professional Studies in Healthcare', was implemented in a hybrid mode, to enable both face-to-face and online components, so as to allow the students time to adjust to the new online learning format.

An internal PolyU grant was attained for the subject leader to employ a project assistant for 10 months to set up the website and to handle the technical issues which arose. The website was constructed based on the WebCT platform, and was evaluated using an online WebCT evaluation questionnaire. These factors will be described in more detail later in this paper.

Operation and use of the website

Seventy-three students took this subject during the semester, of which 44 were radiography students and 29 were optometry students, as this academic subject was common for both disciplines. However, for the rest of this article, the focus will predominantly be on the radiography group.

Students were initially given a 2-h introductory, face-to-face lecture about the academic subject and website. During this session, the tutor was able to log into the website, demonstrate its usage, and navigate the students around the site. Once students had been given the orientation, they were required to log-in to the subject Homepage (Fig. 1) with their usernames and passwords, as assigned by the system administrator.

To enable readers of this article to experience the website, it has been archived so that they may log-in and gain a guest's view of the site at:

http://www.acad.polyu.edu.hk/~orpwhite/or445demo/

For the sake of confidentiality, access is only provided for information in week 1 and for other limited information, but this will enable the readership to get a feel for what the site is all about. However, they will not be able to access the entire site in the way that students registered for the academic subject can do. They will be able to see how the site has been set up, but certain documents will be hidden, which is a useful facility of the system, enabling the tutor to grant access to materials at the appropriate time. After logging-in as a guest, one will be faced with the Homepage

Figure 1 Subject Homepage.

outlined in Fig. 1. One can click on various icons on the Homepage to explore the site and the content of each icon will now be summarized.

Discussion Board

The *Discussion Board* is a very useful tool for both tutor and students. The tutor can post instructions on how to prepare for an upcoming lecture or tutorial session, while the students can post any queries they have regarding the subject, from questions about assignments, to technical problems with the website. Responses from their peers, the subject tutor, or technical staff can help to clarify their problems promptly.

Clearly, the *Discussion Board* and *Chat*, which is itemized later, can provide students with the benefit of learning from peers and can encourage those who are typically intimidated by the face-to-face context of learning to express their opinions through online interaction. It should be noted that while students may work off-campus, such as from the clinical setting or from home, the discussion forum and chat-room offer an ideal opportunity to maintain up-to-date and regular communication with the tutor and peers from remote sites. One Hong Kong-based instructor has gone one step further by requiring students to interact on the Discussion Board and then grade their performance.[6] This instructor found that such an approach helped promote interactions and encouraged active and peer-assisted learning.

Lectures

Teaching materials, in the form of PowerPoint slides, MS Word and Acrobat PDF documents, can be presented through WebCT to allow for anytime, anywhere access for students. Students are required to download their own materials and are provided with relevant information at least one week prior to classes, so that they have time to prepare and to be interactive online.

Tutorials

Ideally, teaching materials for tutorial sessions can be placed in this site, but for the convenience of this site it has been used to clearly outline the students' tutorial time-table.

Links

Another major advantage of the website is that relevant Internet 'links' can be provided for easy access by students. As these links are regularly

updated, this is a useful way for the tutor to provide constantly updated subject materials. It also facilitates the easy acquisition of knowledge by students, as they do not have to search for these materials by themselves. Students are expected to access the sites provided in these links as part of their preparation for teaching sessions.

Supplementary materials

Links provided under this section of the website provide further useful information relating to the subject, which students are encouraged to access but is not an essential requirement for class preparation.

Quizzes

Short quizzes in the form of multiple choice questions can be made available online for students who are keen to self-test their knowledge or learning. These can be presented with the use of the WebCT function known as *Quiz*. Examples of quizzes are provided in week 1. Multiple choice quizzes within WebCT are marked automatically by the system as soon as the students submit their answers to the system. Students therefore receive immediate feedback on whether their answers are correct, and what the correct response should be for each question that they attempt.

Chat

As the academic subject was taught in a hybrid mode, 50% of the lectures and tutorials were conducted online via the WebCT built-in function known as *Chat*. For online tutorial sessions, radiography students were divided into two groups of 15, and one group of 14, and there was one group of 29 optometry students. Each group was allocated a different, fixed time slot each week, and assigned to a different chat room for their online tutorial sessions. At the specified times, students were required to log into their assigned chat rooms and have a real-time online session with the tutor. By having small tutorial groups, communication in the chat rooms between the tutor and the students was easily managed. It also afforded students more opportunities to ask questions and participate in discussions, which was the main purpose of the tutorial sessions. However, for online lecture sessions, the entire class of 73 would be online simultaneously to 'listen' to the tutor. WebCT allows conversations in the chat rooms to be recorded so that one is able to keep a log of all lectures and tutorials for future reference.

Assessment

No formal assessment was conducted online for this module, because of time constraints in establishing the website and as this was an innovative method of instruction for this subject, but this is under consideration for the future. Hence, assessments were carried out using traditional methods, such as a face-to-face debate and a reflective writing assignment, which students completed on clinical placements between weeks 8 and 13 of the semester. Examples of assignments can be viewed on the website, by clicking on *Assessment*.

Under this section, WebCT also has the facility for releasing assessment grades so that the students can view their grades anywhere, or at anytime. As students are allocated individual passwords for the website, each student can only view his or her own grades and those of other students are hidden from them, for confidentiality purposes, even though the tutor is able to input and then view all grades in one site.

Subject evaluation

Towards the end of the semester, a WebCT evaluation is conducted to gather students' opinions on various aspects of the online programme development. For evaluation purposes, the radiography and optometry students all completed the same evaluation form, and the results were combined, so separate details will not be provided. Normally, the students would access the evaluation questionnaire via *Quizzes*, but it has been transposed, for the purposes of this paper, to *Assessment*, so that readers can access the questionnaire and view the questions asked. In other words, the subject evaluation survey was conducted online using the WebCT *Survey* function, which is really the same as the *Quiz* function except that submissions are anonymous. In reality, the tutor is not able to identify who submitted which survey, but can still keep track of who has submitted a response and who has not.

Asking the students to complete a survey online not only saves valuable class time, but also allows students to voice their opinions at any time convenient to them, as long as it is within a given time frame. It also saves the subject leader from having to analyze the data in a spreadsheet programme because WebCT automatically calculates

the essential statistics for each question from all the submissions received.

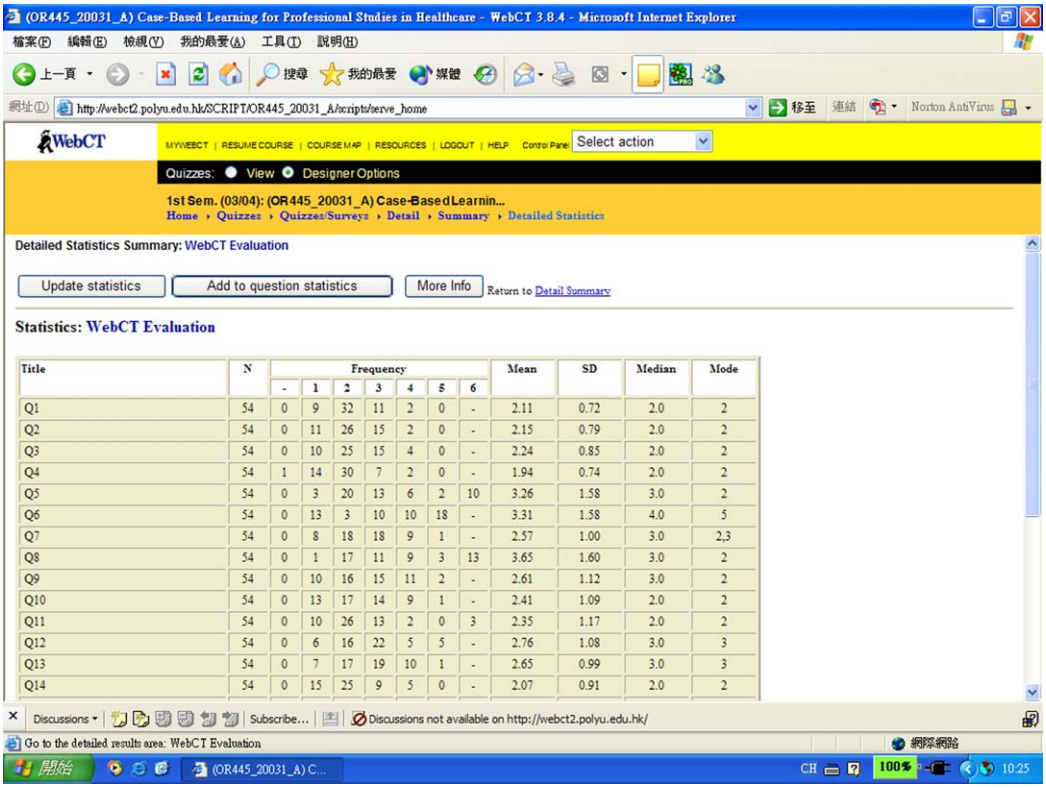
Results of WebCT evaluation

Responses were received from 54 out of 73 students in total, which constituted a response rate of nearly 74%. Fig. 2 shows the mean, standard deviation, median and mode of the results, amongst other information, for each question in the WebCT evaluation survey.

Fig. 3 shows the response summary for question 1 of the survey, where a visual presentation of the results is given in the form of a frequency distribution.

From the results, it was found that 66% of students thought that the online readings and notes advanced their learning, with another 26% saying that they somewhat advanced their learning. It was also found that 83% of respondents either felt confident or semi-confident about participating in the online *Chat* sessions, with 57% saying that the tutor communicated effectively during these sessions. Around 34% of the respondents thought that the *Discussion Board* was useful for communicating with fellow students, while just over 49% thought that it was a good place for the tutor to make announcements. Over 66% believed that the tutor responded to messages and postings in a timely manner, with all responses being given within 24 h throughout the semester, except for on weekends. Furthermore, nearly 70% of the respondents believed that access to the online materials enabled them to prepare ahead for lectures and tutorials. However, when students were asked to comment on the ratio of face-to-face sessions to online sessions, it was found that 34% of students preferred more face-to-face lectures/tutorials. Nevertheless, feedback received was particularly positive, especially when considering that, even though this was not the students' first experience of WebCT and e-learning, this was their initiation into actual, real-time, online lectures and tutorials.

Prior to the implementation of this subject in an e-learning format, radiography students were taught as a single discipline and not in conjunction with the optometry students, so student feedback was solely from the radiography group. Therefore, comparisons cannot be made between the online WebCT evaluation and previous student evaluations. However, student performance in the new and old subject formats can be analysed, as the student grades can be compared.



Title	N	Frequency							Mean	SD	Median	Mode
		-	1	2	3	4	5	6				
Q1	54	0	9	32	11	2	0	-	2.11	0.72	2.0	2
Q2	54	0	11	26	15	2	0	-	2.15	0.79	2.0	2
Q3	54	0	10	25	15	4	0	-	2.24	0.85	2.0	2
Q4	54	1	14	30	7	2	0	-	1.94	0.74	2.0	2
Q5	54	0	3	20	13	6	2	10	3.26	1.58	3.0	2
Q6	54	0	13	3	10	10	18	-	3.31	1.58	4.0	5
Q7	54	0	8	18	18	9	1	-	2.57	1.00	3.0	2,3
Q8	54	0	1	17	11	9	3	13	3.65	1.60	3.0	2
Q9	54	0	10	16	15	11	2	-	2.61	1.12	3.0	2
Q10	54	0	13	17	14	9	1	-	2.41	1.09	2.0	2
Q11	54	0	10	26	13	2	0	3	2.35	1.17	2.0	2
Q12	54	0	6	16	22	5	5	-	2.76	1.08	3.0	3
Q13	54	0	7	17	19	10	1	-	2.65	0.99	3.0	3
Q14	54	0	15	25	9	5	0	-	2.07	0.91	2.0	2

Figure 2 Detailed statistics summary.

Grade distribution for radiography students:

Years 2000, 2001 and 2002 represent students' grades under the previous face-to-face teaching and learning method. Years 2003 and 2004 represent students' grades after the initiation of the e-learning, online format.

	2000	2001	2002	2003	2004
A+ (Outstanding)	0	1	2	2	0
A (Excellent)	4	4	3	2	4
B+ (Very good)	9	10	15	6	10
B (Good)	27	21	15	11	11
C+ (Wholly satisfactory)	14	14	11	5	3
C (Satisfactory)	9	9	7	2	3
D+ (Barely adequate)	0	2	2	2	1
D (Weak)	0	1	1	1	0
F (Inadequate)	0	0	0	1	0

Grades are criterion referenced and similar assessments have been used for all years, i.e. a debate and a reflective writing assignment, so comparison of grades should be comparable. Indications are that student performance has not been adversely affected by the change in teaching and learning format and that e-learning offers an effective alternative to the more traditional style of teaching and learning.

As some students have stated in their evaluation of the online academic subject:

''Nice to have online lecture, it stimulates the interaction in the class.'' (Student 1)

''The online tutorial is flexible.'' (Student 2)

''Good online tutorial/lecture.'' (Student 3)

Technical concerns

As with the adoption of most new technologies, a multitude of difficulties are usually encountered at startup. In a study where 17 instructors from a university in Hong Kong, who were novice web-adopters, were interviewed[6], many respondents reported major startup problems. They had to overcome technical difficulties with the use of the web-based course management system (WebCT in their case), citing that a considerable amount of time was invested just to learn the basic

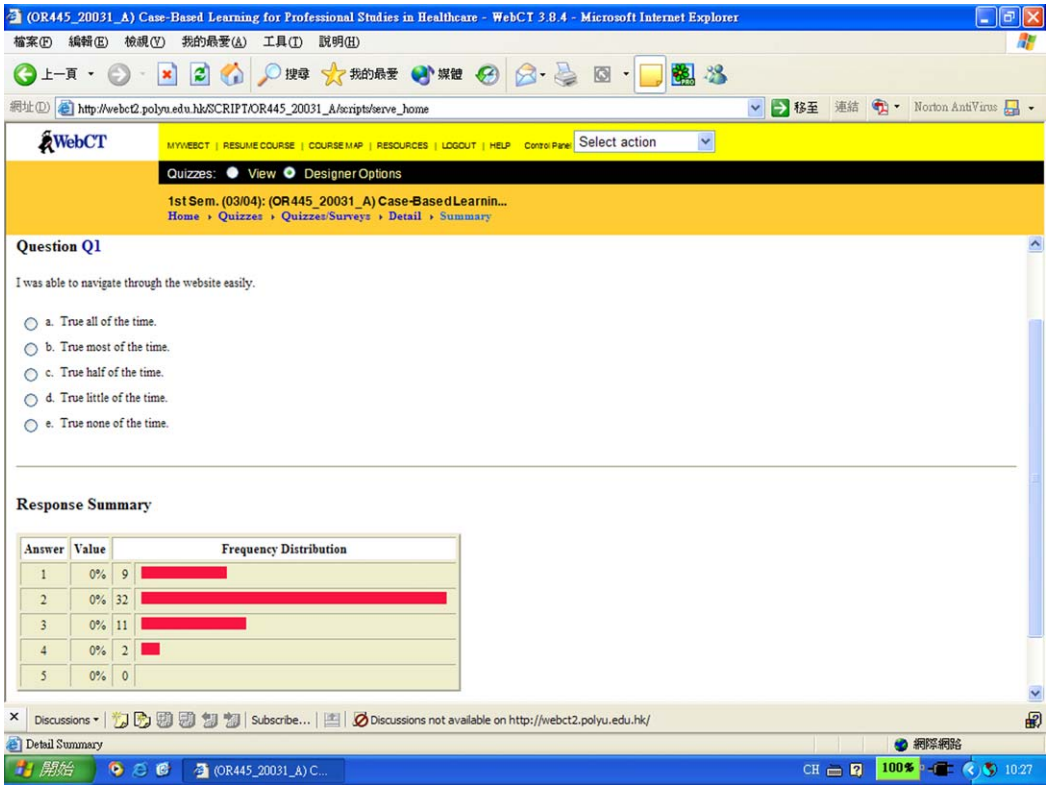


Figure 3 Response summary for question 1.

skills. Individual respondents also found WebCT restrictive in the sense that it could not be easily customized according to their own tastes. Respondents went on to give recommendations for universities that are planning aids for instructors. These recommendations included having more technical support available to instructors, in the form of simple user manuals, workshops to train instructors on technical skills, and a hotline manned by technical staff for telephone assistance, but most importantly, professional advice on how to make the best use of the web in teaching particular academic subjects and how to prepare online learning materials.

In designing and delivering the two radiography academic subjects for e-learning, the authors encountered far fewer technical difficulties as compared with the instructors in the interview mentioned above. This is largely due to the fact that an excellent technical support structure is available at the PolyU, with special assistance for instructors who are in the process of developing their subjects online. First of all, funding was available from the Online Programme Development Unit (OPD) to employ technical project staff to implement subjects on behalf of instructors. A WebCT Help Desk hotline was set up by the Information Technology Services Office (ITS) for staff and students with WebCT-related problems. ITS also conducts a variety of training courses on WebCT and other Internet-related technologies for staff members on a regular basis. The Educational Development Centre (EDC) holds courses, workshops and seminars on technology in education and provides consultancy on the design and delivery of web teaching activities.

All in all, the authors believe that the factors for the successful implementation of e-learning were satisfied. These factors were identified as having an enthusiastic tutor, local support from, and direct access to, Information and Communication Technologies (ICT)-experienced staff, and significant institutional support in the form of funding and encouragement.[2] It is a matter of changing students' traditional perspective on learning, and gradually getting them to embrace technology in education, that will ultimately lead to success for both e-learning providers and students alike.

On the computer hardware and software requirements necessary to facilitate e-learning, an adequately powerful server had to be maintained so that for example, students who were logged on simultaneously to the same quiz would get their responses quickly amidst the increased workload of the web server.[6] A video streaming server will facilitate the delivery of digital videos over the Internet. A broadband Internet connection is highly recommended for students who wish to take online courses with interactive components such as the one mentioned in this paper. Most of the software that a student will need, so as to view course materials, are available freely online for downloads. These include the Macromedia Flash Player, Adobe Reader, and even the Microsoft PowerPoint Viewer, to name a few.

Conclusion

Not only is the profession of radiography developing technologically at a rapid pace in the clinical environment, but vast technological changes are occurring academically too. The computer knowledge of today's learner needs to afford at least basic skills and learners are increasingly dependent on the Internet and the World Wide Web for sources of information. The intended implementation of mandatory CPD for radiographers in the UK places increasing pressure on practicing radiographers to meet the minimum requirements for maintaining state registration and it would be useful to investigate the implementation of such a facility for CPD purposes. It appears that lifelong learning is upon us and is here to stay, so the facilitation of participation of individuals is a major concern. Clinical practitioners, course providers and other relevant stakeholders, such as employers and academic institutions, need to be proactive in determining innovative ways to facilitate both undergraduate and post-registration development and learning. This paper has outlined how e-learning can be utilized to benefit learners who wish to work at their own pace and who need not attend academic subjects at sites which are remote for them. Learners can benefit from working off-campus, while still maintaining interaction with their tutors and peers.

The initial implementation of an online learning format may take a lot of time and endeavour at the outset, but this should not discourage it from happening, as the long-term benefits as a whole are worthy of consideration. Although this article focuses on undergraduate learning, in terms of CE/CPD, time and cost constraints are often at the forefront of limitations which have been identified. The authors would like to suggest that the more we can aid in overcoming these limitations, the greater the benefits to individuals within our profession, and this will lessen the resistance to participate in CE/CPD in the future. By affording learners more flexibility and providing guidance for them, by means of a website, this will help to allay

fears and hopefully promote a positive attitude to lifelong learning.

Acknowledgements

The authors would like to thank the Online Programme Development Department of PolyU for the provision of financial assistance to support the development of this academic subject into an e-learning mode. We would also like to acknowledge the support and assistance received from both EDC and ITS, at PolyU. Finally, we would like to thank Eric Wong Yiu-hing for arranging to have this website archived, so that it can be accessed and explored by the readership of this article.

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