Teaching Web Applications Development in a Fully Online Environment: Challenges, Approaches and Implementation

Dr Justin Brown
Lecturer, Computing and I.T.
School of Computer and Information Science
Edith Cowan University
Perth – Western Australia
j.brown@ecu.edu.au

Abstract: *This paper examines the re-development of university level web programming unit for delivery in a fully online mode. The unit, which teaches advanced xhtml, javascript, php and mysql had traditionally been taught only in an on-campus mode, due largely to the development environments required and the technical difficulty of supporting student learning outside of a classroom setting. The unit materials re-development included providing students with a pre-configured, integrated web development environment, demonstration applications discussed in the lectures and built in the workshops, and a staggered delivery of two weeks of materials at a time. This approach was introduced in the hopes of promoting in-depth rather than skim reading/study of the materials. Proven completion of learning materials by a majority of students before the end of each fortnight would see the next two weeks materials released earlier.*

Keywords: e-learning, online learning, web development, applications development, teaching

1 Introduction

Delivery of university course materials, and even entire courses, via the medium of the World Wide Web is neither new nor necessarily revolutionary. A number of commercial of the shelf (COTS) course content and delivery systems are available to support large scale online teaching and learning [1], with features including course management, content management, assessment management, student management and online instructor / student interaction . Blackboard is an example of a commercial e-learning environment used within universities, schools and corporations around the world in order to support the process of teaching and learning. That teaching and learning can be delivered in a number a ways, from a mixed mode or blended approach [2] where students physically attend classes and use the online environment to access their electronic learning materials to support their in-class learning, through to a fully online approach where the online learning environment is the primary source of structure, content, assessment, feedback and scheduling for a course or unit of study.

This paper aims not to discuss different types of online learning environments, or to debate the relative merits or drawbacks of web based course and content delivery systems. The author feels there is significant literature addressing these topics and that it is self evident that web based course delivery is established practice and will continue to grow as the primary method of delivering and supporting courses and learning materials in modern educational institutions. This paper looks to examine how to use such systems when delivering a course of highly technical material that has traditionally been taught in a purely on-campus modality. This paper examines preliminary efforts to redevelop and transpose a unit of study from an on-campus to online mode of delivery, and will form the basis of future work which examines the relative success or failure of the approaches presented here.

2 Background

This author's background as an academic staff member within a university school of computer and information science lies primarily in teaching technical subjects, including web applications development, database systems and information security. Each unit within a semester consists of approximately 40 hours of instruction; typically featuring a number of assessment items and an end of semester examination paper. As the school in question embraced the world wide web as a medium via which to deliver electronic learning materials, more and more courses, and the units which they contained, were re-designed for delivery in both on-campus and online modes (formerly known as external studies) [3]. Some units proved extremely difficult to redesign for a fully online mode of delivery due to the technical content of the unit and the need for specialized software or hardware requirements, most of these units being located within the computer science and software engineering courses. To this date, the problem with delivery of such units online has seen those courses remain predominately designed for on-campus delivery. One unit of teaching which exists within an internet computing degree, and finds itself taught also within the aforementioned computer science and software engineering awards is one which focuses on web applications development. The unit, known as Interactive Web Development, is a second year, second semester unit and is designed to teach theory and practice to students in regards to server-side web applications development. The unit is technical in nature and aims to take students from a basic understanding of client and server side technologies, such as XHTML and PHP, to an advanced understanding such that the student is capable of designing and implementing a non-trivial integrated web application using XHTML, JavaScript, PHP, MySQL, and IIS / Apache.

The unit has always run on-campus and typically had student enrolments of between 80-100 students. The first assignment for the unit requires students to deliver an interactive cd-rom based project which is delivered in the form of an XHTML website featuring JavaScript for menus and pop-up windows and Cascading Style Sheets (CSS) for interface design. The second, main assignment requires students to build a server-side web application using PHP as the scripting language and MySql as the data repository. The assignment specification tries to be as authentic as possible and usually takes the form of a management interface onto a relatively straightforward data store. The topic of the assignment changes each semester, and a search of the web is conducted beforehand to ensure that a similar system is not available for download. A final end of semester examination covers all the topics raised throughout the semester, with a heavy focus on students demonstrating all aspects of web application coding techniques.

The unit is taught in a two hour lecture which covers theory with some reference to practical examples, followed by a one hour workshop (or tutorial) where students conduct hands-on coding exercises.

3 Issues with online delivery

A number of reasons existed as to why Interactive Web Development had not previously been taught online as well as on-campus, including;

3.1 Technical Concepts

The technical nature of the unit required a large amount of hands-on practice and experimentation by students, with frequent assistance from the unit instructor(s). Because students were being asked to learn and distinguish between client and server side technologies, and to build solid understandings of these concepts as the foundation for passing assessments, having an instructor on hand to clear up logical versus syntactical errors seemed essential.

While the theoretical and conceptual materials covered in the lectures and readings could be absorbed and understood by students without necessarily having a staff member on hand, the workshop component of the unit posed the greatest problem in re-developing the unit for online teaching purposes.

3.2 Teaching Environment

Once again the workshop environment was another cause of concern for online delivery of the unit as students required access to a web server configured to interact with PHP and MySql. In order to ensure that the teaching materials were consistent, that would initially have required students to install Internet Information Services (IIS) for Microsoft Windows, after which PHP and MySql would require installation, plus the addition of further supporting tools such as a GUI interface onto MySql. While technically it was not difficult to write instructions on how to download and configure these tools, experience teaching the unit showed that not all students used the Windows operating system, or at least not a version that was capable of supporting IIS (Windows XP Home being the most common offender). Apache was investigated as a possible replacement for IIS due to its open source, cross platform nature, however IIS was required for other units within the school and the implementation of another web server was considered a replication of effort on behalf of the technical support staff. At the time, configuring Apache to work correctly with PHP was not trivial, and feedback from students who had tried setting up Apache and PHP on their home systems indicated that getting a reliable solution where code written at home world work on-campus was elusive.

3.3 Assessment Marking

Early in the history of the unit both the first and second assessments were submitted on cd-rom, from which copies could be taken onto the desktop, where the assignments were marked. Because of the server-side nature of the second assignment, students were required to submit their web folders, with correct paths, and the folders that contained their databases. This procedure proved difficult for a number of reasons. Firstly, students did not always include the correct files, especially the database folders, making it difficult, if not impossible to get the application running. Students would often have their databases configured with passwords are other security mechanisms, but fail to include the details with their assignment documentation. Some features of PHP, such as sessions, global variables and magic quotes proved problematic if students developed their assignment off-campus on machines with different configurations. It often took more time to set-up and run a student's work than it did to mark it, leading to email and telephone exchanges between instructor and student to get the assignment to a point where it could be marked.

Approximately four years ago it was decided that the second assessment would be marked entirely in-class, with students being given around ten minutes of time to demonstrate and explain their application implementation. It was the responsibility of the student to have their assignment running and ready to demonstrate when their allotted presentation time came about. The benefit of this approach was that the instructor could tell the student what values to enter into the system for testing purposes, explaining the features they were looking for. Students were presented with an online marking key for each of the 20 assignment elements, this marking key filled in by the instructor as the application was being assessed.

This proved an extremely effective method of assignment marking as students knew exactly what their grade for the assessment was and the reasoning behind it, almost completely eliminating assessment appeals for this particular assignment. Once the online marking key was filled in, the instructor submitted the form and a summarized score was presented, which the student could then printout and keep as their copy. All assignment code and an application functionality descriptions were then uploaded to the school's e-learning Content Management System (CMS,) so that assignments could later be checked for evidence of collusion or plagiarism. While the in-class approach solved many problems of assignment configuration and assessment appeals, it required a great deal of effort on behalf of the teaching staff, often requiring several full days to complete all assessment marking.

4 Drivers for change

The school in question had been using its own in-house developed e-learning CMS successfully for several years, though the university itself used Blackboard as the institutional standard for supporting online learning. When the school in question made the decision to transfer all units to the Blackboard environment, the decision coincided with the addition of more units to be delivered in an online mode, which included Interactive Web Development. The decision was taken by this author to completely redevelop the content and delivery approach for the unit, working on the assumption that all students in all semesters would be working online. In fact, the unit was slated to run fully online in first semester and in a mixed mode in second semester, with both on-campus and online students enrolled in the course.

While the decision to make Interactive Web Development available as an online unit was taken at the school level, work was already in progress examining how the unit could successfully be transitioned to this mode of delivery, with a particular focus on those issues raised in the previous section. As well as the inevitability of the unit being required for online delivery, another driver for the transition was the changing learning approaches used by students enrolled within the school. For approximately five years leading up to the move to Blackboard, the school had delivered all learning materials via its in-house e-learning environment, for both on-campus and online units. Anecdotal evidence, combined with data collected during this author's doctoral work, indicated that even on-campus students were working more and more in an online mode [4], seeing the course delivery system as their primary interface with a unit [5], followed by the workshops, followed by the lectures. Though class attendance was usually high earlier in semester, attendance would drop off each week, typically spiking just before assessments were due, with students attending in order to seek assistance with their work. Essentially, though the unit in question was being taught in an on-campus mode, the use of the web as a content delivery medium had increased student reliance on weekly learning materials but reduced the proximity between the students and the class as the primary focus of learning and discourse [4].

5 Unit re-development for online delivery

To address the issues raised thus far, the redevelopment of Interactive Web Development for online delivery was focused on three main areas, exposition, environment and content delivery. Another area which was considered 'standard' regardless of delivery mode was communication, which included heavy reliance on email, forums and synchronous messaging services [6].

6 Exposition

Before the redevelopment process, lecture and workshop materials, though aligned as closely as possible, did diverge as the semester progressed. This was due to the nature of the lectures, which dealt with the concepts of the internet and web applications, while the workshops more heavily focused on the practical elements of the unit, taking students through scaffolded, comprehensive instructions on actual coding techniques and practice. For example, Table 1 illustrates one of the weeks (or modules) of teaching where the workshop materials did not reflect the topic covered in the lecture materials;

Table 1: Divergence of lecture and workshop materials

7	**Enhancing web application security: the role of firewalls, smart coding and system auditing** Students will be given an overview of the security issues facing both web application developers and those responsible for configuring and maintaining web servers.	**Lecture** [download .ppt 571 Kb] • Concepts in web security • Points of weakness • Attack types and methods • Firewalls • Coding against attack • System auditing and event logging **Workshop** [download .pdf 290 Kb] • Inserting data into MySQL using PHP / Forms • Database driven list boxes • Server-side form validation • User login functions

This divergence of materials was avoided where possible, however certain topics needed to be introduced in the lecture materials at specific points within the semester, even though the workshops followed a specific flow of critical application development skills [7]. In this case web application security was raised as a lecture concept due to the fact that students would start using their web server implementations heavily at that point in the semester, and they needed to be aware of the security implications of using these tools. While a workshop on the actual design and implementation of web server security was desirable [8], in the context of the managed computing laboratory environment, it was not practical [8].

A decision was made to establish a more direct link between the lecture and workshop materials, so that the lectures contained conceptual and practical content that formed the foundation of the actual hands on skills taught in the related workshop. To this end, example web applications relevant to the weekly learning materials were developed, these applications being examined from a functionality and code perspective in the lecture materials. The weekly workshop materials were designed to get students working on those same applications, effectively putting the lecture materials into practice. Figure 1 shows part of an example application as discussed from an interface and logic point of view, while Figure 2 illustrates a section of the related workshop materials where students build a working model of that example application.

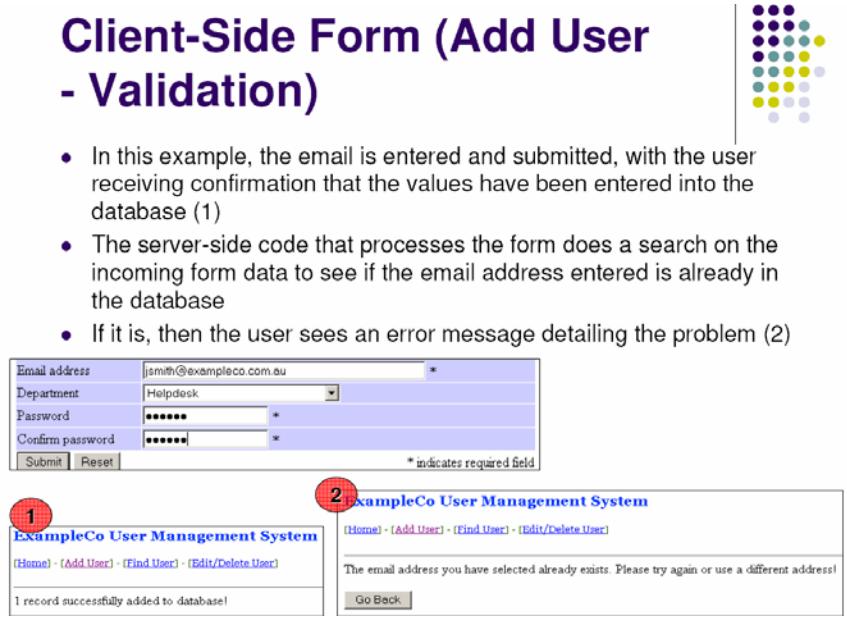

Figure 1: Excerpt from lecture content

likely, that the user has signed up before and forgotten as much. Scroll down to the end of the php validation code you entered last week and add the following code so that it looks like that below.

```
46  @ $db = new mysqli('localhost','root','','usersdb');
47
48  if (mysqli_connect_errno())
49   {
50     echo 'Could not connect the database - please try again later';
51     exit;
52    }
53
54  $query = "select * from userdetails where EmailAddress = '".$EmailAddress."'";
55  $result = $db->query($query);
56  $num_results = $result->num_rows;
57
58  if ($num_results > 0)
59  {
60  echo 'The email address you have selected already exists.  Please try again or use a different address!';
61  echo '<form>';
62  echo '<input type="button" value="Go Back" onClick="history.back()">';
63  echo '</form>';
64  exit;
65  }
66  $result->free();
67
68  ?>
```

Lines 46 – 52 simply connect the script to the database and check to see that the connection is working

Lines 54 – 56 create and execute the query to search the database for the email address sent from the form in *register.php*.

Lines 58 – 65 check to see if the results have more than zero records, indicating that the email address was found, and thus it exists. If it does, an appropriate message is shown to the user, with the usual *Go Back* option.

Task 4: Inserting Data

Before testing the code above, enter the following code directly below (from about line 68 onwards);

Figure 2: Excerpt from related workshop content

Where possible, the new sequencing of the unit materials tries to eliminate lecture materials not relating directly to applications of that knowledge in the form of hands on workshop exercises. As Table 2 illustrates, only two modules within the new structure do not have direct correlations between the lecture materials and workshop materials, these being lectures two and 11. Project management was considered as a critical lecture early in the semester as previous experience teaching the unit indicated that initial preparation and planning of both the approach to unit workload and assignment development was beneficial to student learning outcomes, with the benefit of easing student's fears about the significant workload required for successful completion of the unit.

Table 2: Revised unit structure

Week/Module No	Title	Lecture	Workshop
1	Web Server and Database Server Environments and the Architecture of Web Applications, Protocols	Web Servers, Database Servers, Connectivity, Client-Side, Server Side, Database and Forms	Setting up Web/Database Server Environment (XAMPP), Basic PHP Pages and Testing
2	Project Management and System Delivery	Project Management, Documentation, Dealing with Clients and System Planning and Delivery	Forms and Methods / Basic PHP / Variables / Formatting / Echoing / Printing
3	Database Design for Web Applications	Databases for Applications, Database Planning, Requirements and Normalisation	Database Creation, Population and Manipulation in MySQL

4	Linking Client Side Forms to Server Side Data #1	Client and Server Side Data Validation	JavaScript for Forms / PHP Data Validation, Connecting to Database
5	Linking Client Side Forms to Server Side Data #2	The Six Fundamentals of Web Applications (input, output, updating, deleting, conditions and validation)	Insert, Retrieving, Deleting and Updating data, with conditional validation for each and drop-down lists
6	Conditions, Loops, Calculations and Date/Time Values	Conditional Statements, Loops, Manipulating Numbers, Dates and Times in PHP	Conditions, Loops, Performing calculations on numbers, currency and date/times (both from client side and server side data)
7	State Management and User Authentication	Sessions for State Management, Authentication and Security	PHP Sessions, Creating, Reading and Unsetting, Authenticating Users
8	Advanced State Management Applications	Carts, Logging, and Auditing	Sessions and Databases, Logging, Filtering
9	Efficient Coding Practice	Functions and Include Libraries	Functions, Include and Required Files
10	Integration and Testing	Version Control, Environment Testing, Application Flow, Logical Validation	Application Run-Through, Function Linking and Testing, Added Extras
11	Web Development Security Issues	Server and Database Config, Certificates, Threats and Defence	Work On Assignment
12	Unit Review	Unit Review / Exam preparation	Assignment Submission

Module eleven of the redeveloped unit contained a detailed lecture on the technical and logical concepts of web applications security, while the issue of web server security from a practical development perspective was covered in the initial workshop. The first workshop walked students through the process of setting up their web development environment, pointing out that development environments were often less secure than production environments, and that there were a number of security issues they would need to address before starting their web development. These issues include blocking certain ports from external access, ensuring that server components such as the web server and database server had to be started manually and not as a background service, and that a direct connection to the internet was not advisable while working on with their development environment [8].

Essentially, the previous demarcation of lecture concepts versus workshop application had been altered, so that workshops were largely extensions of the lectures, rather than generally related to them. This allows for a greater depth of the technical concepts which students seem to prefer, and make the materials more self contained, no longer necessarily requiring a lecturer to explain why the context of the lecture materials did not necessarily match that of the workshop materials (as they were now directly interleaved).

7 Environment

Earlier discussion indicated that setting up a consistent web development environment was a non trivial task and resulted in a reliance on class based software tools. However, over the past two years a number of extremely stable integrated development environments have emerged on the web. These environments include the basic building blocks of open source development tools, in this case, PHP, MySql and Apache web server. Though a number of these tools were experimented with during this time, one of the easiest to use and configure was XAMPP, released as a project by the Apachefriends group (www.apachefriends.org). XAMPP is cross-platform, being available on Windows, Linux and Max OS X. It is frequently updated and contains the latest versions of Apache, PHP and MySql, with the benefit that both PHP 4.4.0 and version 5+ are supported within one configuration (see Figure 3).

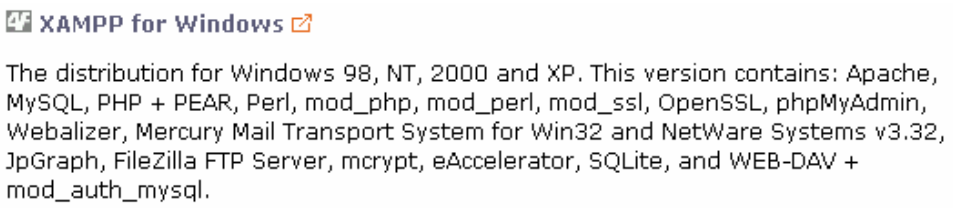

Figure 3: XAMPP integrated development environment features

Aside from a text editor, which is easily obtained from any number of free download services, XAMPP contains all the development tools required to complete the Interactive Web Development unit materials. To this end, the redeveloped workshop materials no longer make reference to class based computer systems or laboratory machines. In the first week of the unit students are asked to download and setup XAMPP on their home system, a task which is extremely straight forward given the single file installer (for Windows at least). Once installed, XAMPP provides a control panel that allows users to start and stop the web server and database system, plus a web based interface onto the web server environment. A web based GUI interface onto MySql, phpMyAdmin, is included and is integrated into the local XAMPP homepage.

The first week of lecture materials discuss the concepts of web servers, scripting languages and database server environments, with specific mention of integrated environments. In the workshop, students then download the XAMPP environment and set it up, test it and become familiar with the various components. A preconfigured version of XAMPP is also available for students, one which can be downloaded, unzipped, and run directly from a public folder on any laboratory machine within the school. The only difference between this version and the student installable version is that the http port number has been changed to 8080 so as not to conflict with IIS in the labs, and the root path for the XAMPP folder changed so that it resides in the c:\inetpub\wwwroot folder, which any student can read and write to. Thus, students can run the pre-configured version of XAMPP at home, and if necessary, bring the entire environment folder structure onto campus and use it within the labs, knowing that the system will work consistently and reliably.

As well as students receiving instruction on how the components of the integrated environment work together, they are shown the physical paths on the system where the various web folders and database folders are stored. This has the double benefit of allowing students to copy and transport only the files they need rather than the entire environment, while at the same time indicating to them the files that are needed for assignment submission. Students are informed in their assignment specification document that they are required to submit their folders containing their PHP scripts and their MySql database(s) and that these will be marked within the same XAMPP configuration that they have been provided with. Students are told that the expectation is for the folders to be dropped into XAMPP and assignment marking to begin. Any non-standard configuration that causes errors will lead to subtracted marks for that feature, or time penalties if extra work is required of the lecturer or instructor to mark the assessment.

The provision of the XAMPP integrated environment, along with the fact that PHP and MySql scripting begins as of module one as opposed to module six in the old structure is hoped to provide a development and knowledge base from which students can build confidence as well as non trivial web applications.

8 Content delivery

While the content of Interactive Web Development has been completely rewritten and redesigned for online delivery as the assumed default mode of delivery, new approaches to delivering the revised materials are also being integrated into the unit change. As a part of this author's doctoral research, methods of controlling content delivery via performance based rules and criteria indicated that focusing student attention on the 'work at hand' had some benefit to the online teaching process. One of the drivers of that research was the issue of students having access to an entire semesters worth of material for their units within the schools e-learning environment. Students expected all materials to be available at the beginning of semester, and would often complain if they were not. As the semester continued and the weekly lecture and workshop materials were updated, tweaked or enhanced, some students would complain that the work had changed since they had downloaded and printed it. However, though it was apparent that students downloaded all materials as soon as they were available, it was less apparent that they actually used those materials, or at least not in the sequence and time frame that was expected. Workshops were most heavily sought, due mainly to their relation to skill building for assessment completion, followed by lectures, followed lastly by readings. Students would often ask the lecturer and instructors questions related to completing the assessment or studying for the exam, even though most of the answers were already available within the unit materials. Students would seemingly complete the workshops first, then set the lecture and reading materials aside only for the purpose of exam revision [9].

To this end, the redesigned materials for the unit are being delivered using a staggered approach, where students receive two modules/weeks worth of materials at a time. Using Blackboard's time release feature, modules can be set to be unavailable initially, but become available at a preset time. Students have also been informed that if a bulk of enrolled students emails their completed (working) workshop exercises to the unit lecturer before the end of each two week period, then the following two weeks will be released earlier. Each two module/week group of materials will also contain short Blackboard quizzes, allowing the unit lecturer to gain some insight to the ongoing level of student comprehension of the learning materials [10].

While this approach may seem more somewhat constrictive and dictatorial, there is some evidence that some students are poor self managers, and that by providing all materials up front at the commencement of semester, some students leave their learning too late. This is particularly problematic in units with heavy workloads such as Interactive Web Development, as once a student gets behind in their learning by a few weeks, they often struggle to catch up again, at least enough to allow them to pass their assessment items.

The concern of high content access but low content utilization led to the question of whether a controlled approach to content delivery might lead to a more consistent interaction between students and the online learning content, which may in turn lead to better student learning performance. "I suspect that the WWW is an ideal medium for good self-regulators, but that it will turn out to be a deadly place for poor self-regulators" [11]. It is too this end that this variation of the normal learning content delivery approach has been adopted.

An online learning system is not really effective unless it delivers appropriate content via an instructionally sound method (in the context of the organization in question), doing so in a manner that both motivates learners and helps them achieve their educational goals [12, 13].

9 Conclusion

This paper presents an approach to delivering a university level web application development unit in a fully online mode, where students rely heavily on the learning materials and development environment for unit completion. At the time of writing the changes had been implemented and the first two modules of teaching had been made available. To this end, the contents of this paper are a 'work in progress', from which it is hoped further research can be derived. Currently, student usage of the new course materials are being tracked by the statistical usage mechanisms in Blackboard, and targeted surveys will be given to students throughout the semester in order to gauge student reaction to the new delivery environment. Data from students who have attempted the unit previously and are now repeating will be particularly interesting,

as their perspective will be based on the before and after transition of the unit content and delivery approach.
This author feels that within the area of e-learning a gap exists in the research regarding how e-learning systems can be used to teach technical materials, a concern supported by Reeves who states that;

> "I was concerned initially about teaching programming online since I feel that my presence in lecture and lab with the students facilitates the learning process considerably. I did not know how to replace "my presence" in the Web course."
>
> [14]

While adaptive web and hypermedia systems have examined this problem, particularly within the work of Brusilovsky, these systems remain complex, topic specific and tend to be research test beds rather than applicable, large scale content delivery mechanisms. It is hoped that some or all of the approaches suggested here in the context of teaching web development will prove beneficial to the online teaching process, and act as a possible guide to instructors facing similar challenges in other technical fields.

References

1. Grutzner, I., N. Angkasaputra, and D. Pfahl, *A systematic approach to produce small courseware modules for combined learning and knowledge management environments*, in *Proceedings of the 14th international conference on Software engineering and knowledge engineering*. 2002, ACM Press: Ischia, Italy. p. 533-539.
2. MTS, *e-learning FAQs*. 2003, Ministry Training Source.
3. Brown, J. *Virtual Universities and E-Learning Adoption: one size does not fit all*. in *4th International We-B 2003 Conference*. 2003. Perth, Western Australia: Edith Cowan University.
4. Chabonneau, K., *Jim Berger - What's the Secret to Start Teaching Online?* 2005.
5. Parker, M., *Technology-enhanced e-Learning: perceptions of first year information systems students at the Cape Technikon* in *Proceedings of the 2003 annual research conference of the South African institute of computer scientists and information technologists on Enablement through technology* 2003 South African Institute for Computer Scientists and Information Technologists. p. 316-319
6. Anane, R., et al. *eLearning content provision*. in *Database and Expert Systems Applications, 15th International Workshop on (DEXA'04)*. 2004.
7. Yue, K. and W. Ding, *Design and evolution of an undergraduate course on web application development* http://doi.acm.org/10.1145/1007996.1008005, in *Proceedings of the 9th annual SIGCSE conference on Innovation and technology in computer science education*. 2004, ACM Press: Leeds, United Kingdom. p. 22-26.
8. Brown, J. *Identification And Integration Of Information Security Topics In A Web Application Programming Course*. in *Security Education and Critical Infrastructures*. 2003: Kluwer Academic Publishers.
9. .
10. Lundquist, R. *Quiz collaboration –- cheating or a learning opportunity?* in *World Conference on Educational Multimedia, Hypermedia and Telecommunications 2001*. 2001.

11. Pathak, S. and P. Brusilovsky. *Assessing Student Programming Knowledge with Web-based Dynamic Parameterized Quizzes*. in *ED-MEDIA'2002 - World conference on Educational Multimedia, Hypermedia and Telecommunications*. 2002. Denver, Colorado: AACE.
12. Brooks, D., *Web-teaching : a guide to designing interactive teaching for the World Wide Web*. Innovations in science education and technology. 1997, New York: Plenum Press. xix, 214.
13. Lytras, M. *E-learning pedagogy: The reveal of value adding learning processes. Definitions and Implications for dynamic learning content delivery*. in *World Conference on E-Learning in Corp., Govt., Health., & Higher Ed. 2002*. 2002.
14. Horton, W., *Using E-Learning*. ASTD E-Learning. 2002, Virginia: American Society for Training and Development. 169.