

An Architecture for a Truly Online Classroom

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Abstract

Currently, there is a shift from standard classroom-based teaching to focus on novel delivery methods. A common technique employed in recent years is that of E-Learning or Web-Based Training. Normally e-learning technologies are used as part of a blended learning approach, where the learning takes place in the classroom / laboratory and the learning management system (LMS) is used simply as a means of communication with the students. Many users of e-learning technology use the LMS merely to store notes. Others use it for discussion forums and assignment submission. All of these tasks can be accomplished very easily using a standard web site.

In the Centre for Cybercrime investigation in University College Dublin, the M.Sc in Forensic Computing and Cybercrime Investigation is being taught entirely online¹. All lectures are delivered online and are available through a Moodle server. Students and facilitators meet using virtual meeting room software and freely available applications such as Skype. Finally the students are able to access a virtual laboratory in which all of the software that they need is available. The students access all of these resources through the Moodle web interface.

In the past two years more than 50 students have used this technology. The results have been overwhelmingly successful, from both the teacher's viewpoint and the student's. To date the 47 students have come from 13 separate countries across four continents. The majority, 14, have been Irish, however, students from the USA, Hong Kong, UAE, and Denmark have taken (or are taking) the course. In a survey conducted recently, the majority of the students were delighted with the course. The main reason was for its flexibility, the online nature of the course allows them to more easily balance work, personal life, and college.

1. Introduction

¹ Students are still required to attend examinations

Learning Management Systems (LMS) such as Topclass [WBTSystems 2009], Blackboard [Blackboard 2009], and Moodle [Moodle 2009] are becoming commonplace in third level education. The aim of these systems is to grant more open access to education to the population. An LMS, properly used, facilitates this by allowing the learner to choose when to learn rather than the traditional system in which the learner is told when to learn. The standard classroom-based model is very prescriptive. As a general rule lectures are run once at a particular time. If the student misses this there is no way to get the information. The LMS has the potential to alleviate (or indeed remove) this problem.

Unfortunately in the authors' experience the majority of LMS in use in the third-level sector are used, not as *learning* management systems but as *content* management systems. By this we mean that the LMS is used solely as a repository to provide easy access to lecture notes for students. This use is false! People using an LMS in this way would be as well served to have a standard web page from which links to content could appear.

Many feel that the strength of the LMS is in interactivity, that it provides functionality for the submission and grading of assignments and the provision of discussion forums in an integrated environment. However, these are again *content* management issues. Assignments, and even discussion postings are merely content resources. This approach, of having standard classroom-based teaching with an LMS containing content is commonly referred to as a *blended learning* approach. The drawback of this *blended learning* approach is that of geography. Students must still be physically present in the classroom for the particular class times. One of the original aims of e-learning (or web-based training) was to allow students from any geographic location to have access to education from the comfort of their own homes.

When e-learning was first proposed in the early 1990s [McLoughlin 1996], the web was in its infancy, yet pilot studies were delivered successfully over the web. Since then it appears that the area has progressed little, if at all. Very few courses are delivered through purely online means. In the Centre for Cybercrime Investigation in UCD a new M.Sc programme began in 2006. This specialised course is aimed at law enforcement professionals around the globe. Due to the diverse locations and time commitments of the participants the only suitable mode of delivery for this course was through an e-learning system.

This paper describes the design of the technical infrastructure used in the Centre of Cybercrime Investigation. Philips [Philips 2002] and Romiszowski [Romiszowski 2004] identified three major

factors that lead to the failure of most e-learning projects (both corporate and academic). These failure levels are:

- The product level: this includes poor course design, poor technical infrastructure, and poor social interactions
- The learner level: this includes lack of time / motivation on the student's part
- The organisational level: this includes a lack of dedication to the project from the management levels in an organisation.

In designing this programme it was felt that the level that could be controlled was the product level, hence we looked at designing the most robust and inclusive e-learning system that was possible.

The remainder of this paper is organised as follows. Section 2 describes the proposed course and the profile of the students who would take it. Section 3 describes the requirements that were identified for the successful delivery of the programme. It then describes the technical infrastructure created in the Centre for Cybercrime Investigation in order to meet these requirements. Section 4 outlines the results of the survey undertaken to evaluate the effectiveness of the solution. The survey obtained both quantitative and qualitative feedback. Finally we summarise our findings in Section 5.

2. Course Description

This taught course M.Sc consists of eight modules followed by a minor thesis. All of the learning is done online with the exception of 2 days of practical skills training in Cybercrime investigation that are done at one of the exam sittings. The students are required to take examinations in UCD on three separate occasions during the 2 year duration of the programme.

On this particular course all of the students are in full-time employment with National Police Forces around the world. The schedules that these students have would mean that it would be impossible for them to attend regular classes. The specific nature of the qualification means that colleges would be unable to run this in a financially viable way using traditional teaching methods. As such a distance learning solution was necessary.

3. Technical Infrastructure

During the design of the programme it was necessary to mimic, as much as was possible the resources available through standard classroom-based teaching. In order to do this the course designers studied the necessary teaching techniques and attempted to create these in an online environment. The course designers identified the following resources that were necessary for any successful computing course delivery. These included:

1. Lectures: the lecturer needed to be able to communicate the contents of each lecture to the students. The use of electronic presentations was essential, but a means of actually lecturing was also necessary.
2. Tutorials: small focused groupings of students looking at a particular topic were a requirement
3. Meetings: students should be able to meet with lecturers, tutors or demonstrators
4. Laboratories: students required access to a laboratory for computing practicals. Due to the expensive nature of the specialised software the students could not be expected to purchase the software themselves.
5. Assignment submission: Students must be able to submit assignments.
6. Grading and administration: lecturers must be able to administer their courses and inform students of their grades.
7. Discussions / mailing lists: lecturers need to be able to communicate with all of the students if their is a need.

These were the main requirements that were initially identified. It would have been impossible to proceed without identifying an online solution to all of these issues.

Requirements 5 (Assignment submission), 6 (Grading and administration), and 7 (Discussions / mailing lists) were the simplest to meet. Any LMS is able to handle these tasks. For many reasons, Moodle [Moodle 2009] was chosen as the LMS to build the system from. One of these reasons was of course cost. As an open-source project Moodle is a free learning management system, it provides similar functionality to that of its commercial competitors such as Topclass [WBTSYSTEMS 2009] and Blackboard [Blackboard 2009]. It allows the creation and management of courses and of students, it allows the submission of assignments and their grading, and finally allows for discussion boards and mailing lists. Finally like all learning management systems it allows for the management of content to be delivered to the students. However, Moodle by itself does not allow the other functionality to be delivered to the students. The final advantage that Moodle has is its customisability, Moodle can be made to appear as the administrator wishes and can also be integrated easily with other software packages.

In order to allow for the delivery of lectures online a *voice over powerpoint* style was adopted. This was facilitated by a Macromedia product called Breeze which allows for the creation of voice overs for powerpoint presentations. On installing Breeze on a machine an extra menu appears in powerpoint which will allow you to record the audio easily. In conjunction with this there exists a Breeze streaming server. The audio lecture is streamed from this server, which is linked to from

Moodle, allowing seamless interaction for the students. A student's view of the lecture is shown in Figure 1.

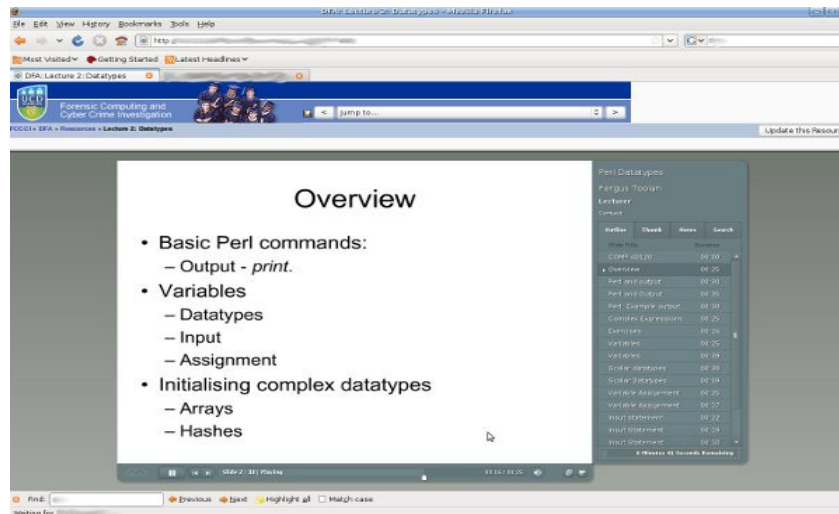


Figure 1: Screenshot of a lecture.

Tutorials and meetings can be facilitated through use of the Breeze server's meeting room software. This allows public or private meeting rooms to be created for meetings or tutorials. Again the students are able to access these rooms through the Moodle interface. Students can make *appointments* in the virtual world in order to meet a lecturer or tutor at any stage during the course. The meeting rooms provide the following functionality to all participants:

- the ability to communicate with instant messaging (text-based chat);
- the ability to communicate with voice / video link;
- the ability to exchange Files (documents);
- the ability to show other users your computer screen;
- a shared virtual whiteboard that all can write on.

Tutorials / meetings can be conducted in these rooms. Students can show work to the teachers and problems discussed in a virtual world that mirrors the majority of outside class student / teacher interaction. Lecturers can also have meeting hours that any student can *pop into* at any stage knowing the lecturer will be present.

The requirements (and solutions) identified to this point are universal across all disciplines in third-level. There will always be a need to provide students with lectures, tutorials, meetings etc. Computing courses have one specific requirement that is not a standard requirement. Students must have access to computer laboratories. In the case of this M.Sc course this is due to the expense of the specialised software. Students could not be asked to purchase this themselves. The college licences it for the college's computer labs but they cannot distribute the software to the students as it would invalidate the licence. This was potentially the biggest stumbling block for the course.

A solution was found through the use of a virtual private network which allowed the students to connect to machines in UCD's School of Computer Science and Informatics on which was installed the required software. Students are able to connect from their home machines to access machines in the labs in UCD, specifically reserved for them. These machines have all of the requisite software. These *labs* also allow the students and lecturers to interact in a way similar to that experienced in normal *classroom-based laboratory*. Students can at any stage request assistance from the demonstrators while the demonstrators have the ability to *look over the student's shoulder* in order to see how they are progressing.

Many have worried that the lack of classroom interaction hinders students' learning [Schmidt 2001, Valentine 2002]. We feel that with the M.Sc course this is not the case. Firstly many theorists have stated that students should be able to pick and choose their learning times to suit themselves. This is particularly important for the students on this particular course who are all in full-time employment. The recorded lectures allows the students to choose when they will *attend* the lecture. They can also listen to the same lecture multiple times if they are having difficulty, or pause the lecture in order to take some extra notes (or merely to take a break). These freedoms have never been available through traditional educational systems.

The students are not losing out on their mainstream counterparts. Many distance learning students feel that they are second class citizens in third-level education, that they miss out on extra advice and tips from the lecturers. There are no distance learning strategies that the authors are aware of which have so much interaction between lecturer and student.

Students can socialise and study together if they wish. The meeting rooms are not only available for the teaching staff. Students can organise to meet in a meeting room at any stage in order to prepare for examinations / assignments or sometimes just to meet and have a chat. This facility is probably under utilised in the UCD system but it is available. In the future we hope to improve this aspect of the system. The students have a great opportunity to meet people from many nationalities working in a similar field to them.

From the lecturer's perspective we have gotten to know the students very well, and have interacted well with them. There is great banter in meetings and on discussion forums that is equal to anything found in a class situation. One possible drawback is the lack of immediate feedback in a lecture. As we lecture in a classroom we are constantly assessing the classes' reaction to the material and

adjusting our pace to handle their reaction. With this online system this is impossible, however, it is our believe that the ability to pause and to replay the lecture helps students to overcome this.

In order to evaluate the effectiveness of the Centre for Cybercrime Investigation's approach to teaching this M.Sc, we conducted a survey of 47 current and past students in order to fully understand the student experience on the course. The students were able to submit the survey anonymously if they wished.

4. The Survey

The survey was provided to the students and they were given one week to respond. Of the 47 students who received the survey 17 responded within the timeframe. The breakdown of the total student population by nationality is shown in Table 1. This demonstrates the universal nature of the approach. Remember that all of these students are employed on a full-time basis in their respective countries. No other delivery means would have facilitated these students coming together to study.

Nationality	# of Students	Nationality	# of Students
Rep. of Ireland	14	Greece	2
United Kingdom	8	Denmark	1
The Netherlands	6	Austria	1
Germany	5	United States of America	1
China (Hong Kong)	3	United Arab Emirates	1
France	2	Cyprus	1
Belgium	2		

Table 1: Nationality breakdown of students on the M.Sc Program.

The survey consisted of eight statements to which the students were required to give an answer on a scale of 1 – 5 with one representing strong disagreement with the statement and five representing strong agreement. The statements in the survey were:

1. I have been able to interact with my classmates through the VLE
2. I have gotten to know my classmates through the VLE
3. I have been able to interact with the teaching staff through the VLE
4. I have gotten to know the teaching staff through the VLE

5. The VLE provides a suitable substitute for classroom-based teaching
6. My education / career development has benefitted from the VLE
7. The VLE provides a flexible way to learn
8. The VLE has made it possible for me to pursue this qualification

4.1. Quantative Responses

The general trend of the survey responders was very positive. Table 2 shows the mean response values, the standard deviations, the maximum and the minimum values for each of the eight questions.

Question	Mean	St. Dev.	Max.	Min.
1	4.18	0.64	5	3
2	3.25	0.93	5	2
3	4.18	0.81	5	2
4	3.41	1	5	1
5	4.2	0.9	5	2

6	4	0.62	5	3
7	4	0.62	5	3
8	4	0.44	5	4

Table 2: Summary statistics for each question.

From Table 2 it is clear that the majority of students were very happy with the online learning experience. Six of the eight questions obtained an average rating above 4, while the other two's ratings were still above three. Looking in more detail at the questions we can see the following patterns emerging:

- Questions 7 & 8 were related to the flexibility of the learning approach. These both scored very highly as students were happy that the learning approach adopted on this course allows them to take this qualification and also to take it at a time of their choosing.
- Question 5 was concerned with the VLE being a suitable substitute for classroom-based learning. The opinion of those surveyed was that this was indeed a valid statement, with the mean score being 4.24.
- The most troubling results in the survey are for questions 2 and 4. While the students were happy that the VLE allowed them to interact well with peers and teachers (questions 1 & 3) they obviously felt that they did not get to know the other participants and teachers as well as they might have done in a classroom situation.

Figure 2 shows the breakdown of the results for each question. From these graphs it can be seen that in three cases (questions 1, 6, & 7) all students gave a score of 3 or above while in one case (question 8) all students gave a score of 4 or five, with the vast majority (more than 75%) giving a five to that question. In six questions more than 25% of respondents gave a score of five, the exceptions to this were questions 2 and 4 regarding getting to know other individuals on the course.

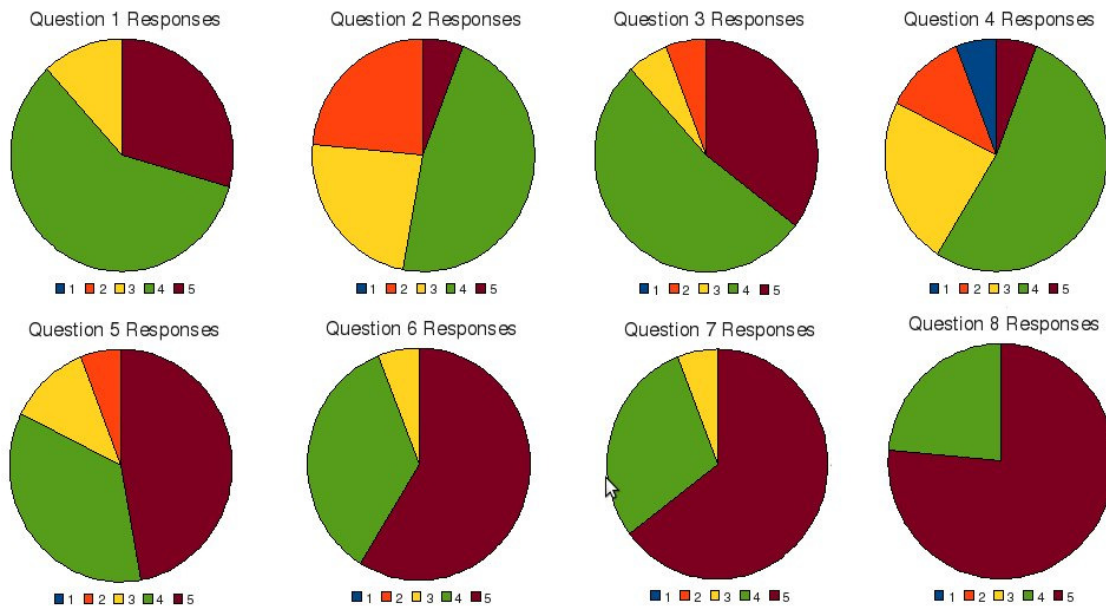


Figure 2: Breakdown of student responses to each of the survey questions.

From this feedback it is clear that the students are very supportive of the online learning experience. In general they see it as a means to achieve a very specialised qualification that otherwise would be unavailable to them. They are happy that the VLE provides a suitable substitute to a classroom-based experience. There only issue with the VLE was that it did not provide sufficient means for the students to get to know each other as they would in a standard classroom situation. The final piece of feedback elicited was a general comment where students were asked to give their feelings on the VLE. The following section explores this general feedback.

4.2. Student Feedback

Of the 17 survey responses 14 students took the opportunity to provide more explicit feedback via the comments section. These were overwhelmingly positive. Many students commented on the flexibility that the delivery means provided. Some of these included

“The flexibility that the VLE allows is its biggest advantage – it means that I have been able to manage my learning around a busy working and home life.”

“I would not have been able to study this course if it had not been online.”

The single most disappointing outcome of the main part of the survey was that students did not feel fully happy that they had gotten to know each other through the VLE. One student's comment reflected this.

“It would be fair to say you 'know of them' rather than knowing them.”

However, we are encouraged with the comments that we received from other students about virtual

meetings they have conducted themselves. They have not been using the features in the VLE to their fullest potential but the following comments show that they have gotten to know each other through virtual means.

“Most contacts with classmates happen over email, nevertheless the VLE enables us to ask questions to the group and share knowledge.”

“With regard to interaction with classmates and lecturers, this was mostly done through emails outside of the VLE.”

While we are disappointed that the students are not using the VLE itself to get to know each other they do seem to be interacting well outside of the VLE. This could be argued to be 'normal' student behaviour, more interaction occurs outside of the classroom than inside.

The biggest advantage of an online learning experience over a traditional classroom experience was summarised perfectly by one of the respondents

“... very useful to be able to replay lectures (doesn't work in real life!)”

We feel that this comment illustrates the single largest advantage an online learning environment has over the classroom environment. It allows for students to assimilate the information at their own pace. Attending as many or as few lectures as they wish. Viewing the easier material quickly and spending more time reviewing the difficult material. As students' learning is an individual thing it is impossible to cater for all students in a classroom situation. The points that some students find difficult others find trivial and vice versa. The VLE allows the students to choose a lecture pace that suits themselves.

Students offered some suggestions for further improvements on the VLE. The most commonly occurring suggestion was that there should be more use of video in the lectures. The students are not requesting that lectures be videoed, what they wish to see is that some of the more technical topics are demonstrated through the use of video. This has been piloted in one course this year and will be expanded in the future.

5. Summary

This paper has presented the technical infrastructure utilised in the Centre for Cybercrime Investigation to deliver the M.Sc in Forensic Computing and Cybercrime investigation. We have described the resources used to deliver the solution and also the results of the evaluation taken by our students. Overall the authors' opinion is that the system is working very well, students are

learning in a flexible manor without losing any of the benefits of classroom-based learning

References

- [Blackboard 2009] Blackboard Inc., <http://www.blackboard.com>, last accessed March 2009.
- [McLoughlin 1996] McLoughlin, H. B. "WEST: An Internet-based Education Delivery and Support Environment", in *Computer Networks and ISDN Systems*, 1996.
- [Moodle 2009] Moodle Technologies, <http://www.moodle.com>, last accessed February 2009.
- [Philips 2002] Philips, V. "Why does corporate e-learning fail?", in *Virtual University Gazette*, June 2002.
- [Romiszowski 2004] Romiszowski, A. J. "How's the e-learning baby? Factors leading to success or failure of an educational technology innovation", in *Educational Technology*, 44(1), 5-27, 2004.
- [Schmidt 2001] Schmidt, E. K. & Gallegos, A. "Distance Learning: Issues and Concerns of Distance Learners" in *Industrial Technology*, Volume 17, Number 3, 2001.
- [Skype 2009] Skype Technologies, <http://www.skype.com>, last accessed February 2009.
- [Valentine 2002] Valentine, D. "Distance Learning: Promises, Problems and Possibilities" in *Online Journal of Distance Learning Administration*, Volume V, Number III, Fall 2002

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