Using Data Mining for e-Learning Decision Making

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Abstract: The initial investigation aimed to examine the paths learners followed when offered the course in a custom virtual learning environment (VLE) which is structured by tasks, course materials and learning resources. However, it quickly became clear that students were spending little time with the course materials online and the time spent with each page was usually less than 20 seconds. Consequently a better understanding of how learners accessed the electronic course materials was needed to evaluate the effectiveness of developing and delivering courses in this way.

By combining data on the activity with content with user profiles it was possible to examine alternate information perspectives and reveal patterns in large volume data sets. Mining data in this way provides ways to learn about learners in order to make effective decisions regarding teaching methods, delivery models and infrastructure investment.

1. Background

The University of Glamorgan's e-College Wales (ECW) project is a European Social Fund (ESF) project aimed at delivering online courses in entrepreneurial business management to learners who would not normally attend a traditional on-campus University course. It is one of the largest e-learning projects in Europe.

ECW adopted a standard virtual learning environment from a recognised vendor. Its choice (Blackboard™) was sufficient for administration of courses and students but it was felt that its presentation of learning materials was not able to support the developing online pedagogy. Not wanting the project to be technology driven, the decision was made to continue to use Blackboard for course management and providing discussion forums but that delivery of course content would be via a separate web service which could be adapted to meet learner needs.

However, the lack of activity-based reporting from this bespoke solution has left it unclear whether the technology is meeting the needs of the learner. This document details the development of tools which import, store, query and report learner activity in the bespoke content delivery platform and is designed to provide decision makers and course developers with an understanding of what e-learners need from e-learning technology.

2. Introduction

"To use the opportunities provided by the Internet, there is an obvious need for the design of learning environments which use the interactive capabilities to the best advantage and are not merely the transformation of print-based material to online delivery." (McDonald and Reushle 2001) [i]

The study examined the activity logs of 345 part-time and full-time e-learning students, from business MA, BA and Foundation degrees at seven partner institutions, over an 8-week period. Analysis was conducted on student activity by course, institution and age group, and examined the specific use of the VLE's print page by both student and staff. In addition, students were surveyed on their reading and printing tendencies, supply of print materials from tutors and students' preferred medium of delivery for course materials.

The key findings showed that 80% of all users accumulated less than one hour a week with the course materials in the VLE, and around two-thirds of all users acquired less than 30 minutes a week. Most looked at large portions of their content for less than 20 seconds and tended to have a low average page view. It also found that over 75% of learners were obtaining print versions either themselves or directly from tutors. The students surveyed raised a number of important points regarding studying online and how they use text-

based materials with the web-based environment.

There is a risk that the adoption of e-learning can become technology driven and the need to achieve a return on investment detracts from the evaluation of the benefit to the learner of this medium. It has been suggested that web-based learning environments have a psychological and physical cost as they "may impact learning achievement due to cognitive overload caused by processing too much information from multiple resources within a very short time and due to visions problems caused by spending long time reading materials from computer screens." (Chang 2003)[ii]

The change of emphasis from getting the learner online and 'into' the technology to understanding the learners' needs and using the appropriate medium for the learning materials is considered a factor in successful delivery as "many distance education planners argue that replacing technology-driven models with a learner-focused, outcome-based 'blended-technology' distance education model will result in increased learner satisfaction and increased attainment of learning objectives by students." (Howard 2001)[iii] This view is supported further when considering that the second most important criteria for evaluating quality in e-learning is that it has 'clearly explicit pedagogical design principles appropriate to learner type, needs and context' (Massey 2002)[iv].

Consequently an understanding of the learner's use of this medium is essential in evaluating the benefit of the technological investments, establishing a sound pedagogy based on learner needs and ensuring the quality of the learning experience. Indeed both the evaluation of student performance and student evaluations of the learning experience are considered elements in the definition of quality with which to ensure distance education meets its goal of 'developing independent learners who can capably apply their knowledge to new situations' (Cavanaugh 2002)[v].

In Karen Rosa's survey[vi] determining the preferred choice of course materials presentation for distance learners, it is suggested that distance learners did not wish to obtain their course materials via the internet. Participants were asked to give their first, second, and third choice for course materials supplied: as printed material, electronic files, or via internet access.

Table 1: Preferred choice of course materials (Rosa 1999)

Group	Print	Electronic file	Internet
MBA students	45.5 %	36.4%	18.2%
MDE students	68%	20%	12%
Comp students	44.8%	44.8%	10.3%
HD group (do not belong to one of the other groups)	47.5%	28.2%	25.6%

This is supported by the fact that students rarely read web pages but simply scan for individual words and sentences (Neilson 1997). The editorial team in e-College Wales was aware of the differences between print and online presentation of text and had adopted guidelines for writing for the web which can be summarised by the following list (Juniper 2002)[vii]:

Keep the lines short. The flickering background of a computer monitor makes reading more difficult, so each line should not be longer than 10-13 words.

Short paragraphs of 150 words or fewer help ensure readers stay on task.

Make ample use of headers, sub-headers and bulleted lists.

Use the active voice rather than the passive

When appropriate, use different media such as images, animation, audio and video intermixed with the text.

3. Approach

There are a number of products which enable statistical analysis of web sites from server logs, but these tend to be geared around enterprise information such as return visitors, how often they return, and most popular pages. The University's marketing department is currently implementing the product Web Trends and an initial test was run on a sample log file. The standard overall views were again present and although customisation of reports was a possibility. The project's programmers believed they could produce the desired reports direct from the source data.

3.1 Definition of the source data

The content delivery service is via Microsoft Internet Information Services

web server, which for a number of different log formats but had been storing its logs in the NCSA Common Log File Format which carried the following information:

Table 2 NCSA Common Log File Format [viii]

remote host name	172.21.13.45
user name	REDMOND\fred
date & time	[08/Apr/1997:17:39:04 -0800]
Requested page	"GET /scripts/iisadmin/ism.dll?http/serv HTTP/1.0"
HTTP status code	200
number of bytes sent	3401

More detail and flexibility in selection of appropriate recorded information is available with the W3C Extended Log format:

Table 3 W3C Extended Log format [ix]

date & time	15/11/2002 04:35:19
clients IP	217.148.40.248
clients username	02084562
server Port	80
request method	GET
page requested	/applications/interface2/index.asp
any query parameters	modulecode=eb1s04
HTTP status code	200
Clients Browser and Operating system	Mozilla/4.0+(compatible;+MSIE+6.0;+Windows+NT+5.0;+.NET+CLR+1.1.4322)
Number of bytes sent	141

The server records every request made by a user and stores it in text files writing one file for each day. To enable analysis of the log file data, these text files were imported into Microsoft SQL Server using a Data Transformation Service (DTS) script. All of the NCSA text files covering the period 15 November 2002 to 23 February 2004 and W3C Extended files from 23 February 2004 to 1 March 2004 were imported using the DTS packages which selected each attribute in the log record and then stored into the appropriate field in the database table. A total of 3,440,837 records were imported covering the period midnight on 15 February 2002 to 23:58 on

1 March 2004. As a result of the DTS script, subsequent daily imports are now achievable.

3.2 Method of analysis

The custom VLE comprises a number of dynamic Active Server Pages (ASPs), a frameset, style sheet, and GUI graphics. The course content is offered via three views: materials, tasks and library resources, with additional pages for guidance and assistance. The design came from the developing pedagogy which aimed to enable learners to choose alternate paths through the course. For example, one perspective was content

driven with the learner being instructed to complete tasks at relevant points in the materials:

Materials view

Another view gave assignment information and a list of the tasks to support completion of the assignment. Each task directed the learner back to a relevant topic in the course materials.

Tasks view

The third view allowed learners to see additional electronic resources, e-journals and gateways to websites for each topic area, enabling the learner to research the subject.

Resources view

As the log files contain every single request made by a user, some work was required in order to extract useful information from the data. A process of filtering out via SQL queries helped remove much of the 'noise' and a view was created that only displayed request for 'valued' pages as listed in Table 4:

Table 4 Breakdown of pages in database view

Opening the custom VLE	index.asp
Content pages and any files from multimedia directories (not images for the GUI)	narrative.asp animation.asp /objects/flash/ /objects/images/
Tasks and assignments	tasklist.asp, taskdetails.asp assignmentlist.asp, assignmentdetails.asp
References, required reading, suggested reading, web sites and PDF documents	resourcelist.asp, resourcedetails.asp /objects/pdf/
One to one tutorial tool (only deployed in 1 module)	projectplanner.asp, projectrequestdiscussion.asp, projectgantchart.asp
User assistance	glossary.asp guidance.asp faqs.asp systemrequirements.asp
Specific use of VLE's printing function (does not record printing via the browser)	printoptions.asp

These records were grouped by username and ordered by date, effectively giving the page-by-page record of the learner's path through the course materials. A web interface was written to enter search

criteria of username, start date and end date for the search period, and type of

activity as illustrated in Table 5:

Table 5 Example Student Log

Study Log for 02083868			
date	**Page**	**query**	**View /secs**
10/02/2003 15:44:20	/applications/interface3/index.asp	modulecode=eb1s02	
10/02/2003 15:44:21	/applications/interface3/narrative.asp	modulecode=eb1s02&coursecode=	1
10/02/2003 15:44:21	/applications/interface3/tasklist.asp	modulecode=eb1s02	0
10/02/2003 15:44:21	/applications/interface3/resourcelist.asp	modulecode=eb1s02	0
10/02/2003 15:44:49	/applications/interface3/narrative.asp	NarrativeId=2158&Level=SubTopic	28
10/02/2003 15:45:01	/applications/interface3/narrative.asp	NarrativeId=2159&Level=SubTopic	12
10/02/2003 15:45:15	/applications/interface3/printoptions.asp	Modulecode=eb1s02	14
10/02/2003 15:45:38	/applications/interface3/narrative.asp	NarrativeID=798&Level=Topic	23
10/02/2003 15:45:45	/applications/interface3/printoptions.asp	Modulecode=eb1s02	7
10/02/2003 15:46:33	/applications/interface3/narrative.asp	NarrativeId=802&Level=SubTopic	48
10/02/2003 15:46:44	/applications/interface3/printoptions.asp	Modulecode=eb1s02	11
10/02/2003 15:46:57	/applications/interface3/taskdetails.asp	TaskID=560&modulecode=eb1s02&topicID=151	13
10/02/2003 15:46:58	/objects/flash/AudioDrama1-3.swf		1
10/02/2003 15:47:45	/applications/interface3/narrative.asp	NarrativeId=818&Level=SubTopic	47
10/02/2003 15:47:49	/applications/interface3/printoptions.asp	Modulecode=eb1s02	4
10/02/2003 15:51:48	/applications/interface3/narrative.asp	NarrativeId=818&Level=SubTopic	239
10/02/2003 15:51:50	/applications/interface3/taskdetails.asp	TaskId=560&ModuleCode=eb1s02&direct=read	2
10/02/2003 15:51:50	/objects/flash/AudioDrama1-3.swf		0
10/02/2003 15:51:58	/applications/interface3/printoptions.asp	Modulecode=eb1s02	8
10/02/2003 15:53:10	/applications/interface3/narrative.asp	NarrativeId=818&Level=SubTopic	72
10/02/2003 15:55:24	/applications/interface3/taskdetails.asp	TaskId=560&ModuleCode=eb1s02&direct=read	134
10/02/2003 15:55:24	/objects/flash/AudioDrama1-3.swf		0
10/02/2003 15:56:01	/applications/interface3/tasklist.asp	modulecode=eb1s02	37
10/02/2003 15:56:04	/applications/interface3/taskdetails.asp	TaskID=564&modulecode=eb1s02&topicID=153	3
10/02/2003 15:56:04	/objects/flash/AudioDrama4-5.swf		0
10/02/2003 15:56:14	/applications/interface3/narrative.asp	NarrativeId=825&Level=SubTopic	10
10/02/2003 15:56:19	/applications/interface3/printoptions.asp	Modulecode=eb1s02	5

The difference between the time of a page request and the time of the previous page enabled the calculation of the time spent on a page. It was this figure that was of most interest as random samples indicated that even when many pages were requested the actual time spent in the VLE was low.

The report was summarised to calculate the accumulated time spent online in the course materials, a count of each browser session started, the number of pages per browser session. From this it was possible to report the usage patterns based on the quantity of pages that were viewed for less than 20 seconds. The 20-second threshold was used to indicate printing or skimming, based on the guide page length set by the editorial team, as would be difficult to read and comprehend the text and any multimedia in that time. The example in Table 6 shows an average page rate of 2.3 pages per minute and just over half the

content being viewed for less than 20 seconds.

Table 6 Example usage summary

Usage Summary	
Search Period:	17 weeks
Total time in VLE:	7 hrs 1mins
Total browser sessions:	50
Total pages requested:	958 pages
Average Page Rate:	2.3 per min
Total page views less than 20 secs:	491 pages
% page of views less than 20 secs:	51%
Average page view:	26 secs

Further queries of the data banded students into ranges based on the accumulated time spent online, the percentage of pages which were viewed for less than 20 seconds and their average page view time during a period of a week. The results are listed in Table 7:

Table 7 Report of weekly user trends

Time	Users	Time with materials (% of users)				Content pages read for less than 20 seconds (% of users)				Average page view (% of users)			
		<30 mins	30 mins - 1hr	1-2 hrs	>2 hrs	<25% pages	25-49% pages	50-74% pages	>75% pages	<20 secs	20-39 secs	40-59 secs	>60
6-12 Oct	115	55.65	25.22	17.39	1.74	0.00	3.48	41.74	54.78	36.52	23.48	20.00	20.00
13-19 Oct	135	58.52	27.41	11.11	2.96	0.74	1.48	45.19	52.59	36.30	31.11	20.00	12.59
20-26 Oct	113	73.45	17.70	7.08	1.77	0.00	5.31	31.86	62.83	48.67	29.20	8.85	13.27
27Oct-2 Nov	112	65.18	21.43	9.82	3.57	0.00	4.46	51.79	43.75	33.93	31.25	21.43	13.39
3-9 Nov	116	65.52	18.10	10.34	6.03	0.00	1.72	38.79	59.48	43.97	30.17	12.93	12.93
10-16 Nov	149	71.14	17.45	6.71	4.70	0.00	6.04	44.30	49.66	38.93	24.16	18.12	18.79
17-23 Nov	194	70.62	14.95	10.31	4.12	0.00	4.64	44.33	51.03	37.11	30.41	12.37	20.10
24-30 Nov	211	62.09	18.96	11.37	7.58	0.00	5.69	42.18	52.13	31.28	26.54	22.27	19.91
1-7 Dec	198	71.72	14.14	8.08	6.06	0.00	2.53	40.91	56.57	44.95	18.69	15.66	20.71
8-14 Dec	202	63.37	18.32	12.87	5.45	0.50	1.49	38.61	59.41	36.14	26.73	15.35	21.78

Most users spent less than one hour obtaining content from the VLE. About one-third of the users had an average page view of less than 20 seconds. These analyses support the hypothesis that the majority of users spend little time with the materials in their electronic format.

Further query of the data reveals that over 3 months, on average 39% of users had spent less than 30 minutes a month with the material in its electronic format.

Table 8 Report of monthly user trends

Time	Users	Time with materials (% of users)				Content pages read for less than 20 seconds (% of users)				Average page view (% of users)			
		<30 mins	30 mins - 1hr	1-2 hrs	>2 hrs	<25%	25-49%	50-74%	>75%	<20 secs	20-39 secs	40-59 secs	>60
1-31 Oct	194	31.96	19.59	22.68	25.77	0.00	3.09	45.36	51.55	24.23	39.69	25.77	10.31
1-30 Nov	321	41.74	15.58	18.07	24.61	0.00	3.43	50.16	46.42	27.41	33.64	21.18	17.76
1-31 Dec	303	44.22	17.16	14.85	23.76	0.33	1.98	45.21	52.48	28.71	31.35	21.45	18.48

3.2.1 *Deviation by exiting students*

It was thought that students who had withdrawn or deferred could be affecting the balance of the spread under **'Time with materials'** as they would stop accumulating time after they ceased study. To check the extent of this possible deviation, the Student MIS database for the total number of students exiting was queried again filtering out all users who had an enrolment status of 'withdrawn' or 'deferred'.

The user sample was significantly reduced, however it was found that there was no significant change in the trends. Consequently withdrawn/deferred students were not filtered from further queries, thus maximising the sample.

3.3 Analysis by user profile

To identify whether there were different types of activity depending on course, age or institution the activity data from the server logs was related to the student MIS database which contained demographic, application and enrolment information. The original sample of 659 students (of which 549 had server logs) was reduced to 335 student records that each held a date of birth and course enrolment details. Of these 304 had server logs.

The ECW project delivers a number of awards at different levels of study: masters, undergraduate and foundation degrees to seven institutions across Wales. The data was analysed on the view of course, institution and age by the three perspectives of percentage of content viewed for less than 20 seconds, average page view and time in the VLE.

The analysis of users by course, institution and age indicated that the accumulated time in the VLE, the percentage of pages viewed for less than 20 seconds and the average page view are reflective of the patterns in the overall usage. Therefore the conclusion would be that there is no significant difference in the use of the VLE in terms of course studied, institution attended or age of the student.

3.4 Use of print-page options

The VLE enables the users to select which page they wish to print. While previous statistics only indicate the time elapsed between the requests for pages this analysis gives a clear indication of users who make specific requests to print:

Table 9 Print requests

	Total	%< 25 pages	%<25- 50 pages	%50-100 pages	%100 - 150 pages	%> 150 pages
6 –12 Oct	42	36	4	1	1	0
13 –19 Oct	40	38	1	1	0	0
20 –26 Oct	35	29	6	0	0	0
27 Oct – 2 Nov	35	27	4	3	0	1
3-9 Nov	46	37	3	4	2	0
10-16 Nov	46	37	4	4	1	0
17-23 Nov	47	40	2	3	1	1
24 – 30 Nov	65	52	5	4	3	1
1-7 Dec	52	44	3	4	0	1
8-14 Dec	51	44	3	2	2	0

The total number of print-option users each week raised questions over the usability and overall value of this functionality in the VLE. While most print fewer than 25 pages a week using this method, there is a small group of users who print a large number of pages in this way.

An examination of users printing more than 25 pages per week reveals that they were a mixture of both students and staff. Across a seven-week period, 31 students records were returned:

Table 10 Student print activity

Total	%	Course	Total	%	College
23	74.1	MAPD	22	70.9	Glamorgan
3	9.6	BA Enterprise	4	12.9	Coleg Sir Gar
5	16.1	Foundation Business Administration	4	12.9	Coleg Gwent
			1	3.2	Llandrillo

As illustrated earlier in Table 11, Glamorgan had a much larger share of the students.

The print option was used by 31 students compared with the 334 students in the page view sample. A high proportion of students who used this print facility are enrolled on the MAPD, even though they are only 18% of the overall number in the study. Similarly, BA Enterprise students were not proportional, with less than 10%

using print although they comprise 42% of the overall sample.

This may be due to the different sample sizes, however, an examination of the staff use of this facility suggests another reason why there is a discrepancy in these numbers. The results indicated that staff from the BA Enterprise at Glamorgan and Coleg Sir Gar were the main users of the print options page method of printing and that four out of these nine staff members printed more than 100 pages from the VLE

during the eight-week period of analysis, and we shall see later that many staff were supplying students with printed copies of course material.

3.4.1 Table 11 Staff printing usage: 6 October – 23 November

34	drobert3	Coleg Sir Gar	BA Ent
36	aksussex	Coleg Gwent	BA Ent
50	sabbott	LRC Staff	-
53	djames	Coleg Sir Gar	BA Ent
75	wpjones1	Uni of Glam	BA Ent
110	jwilliam	Coleg Sir Gar	BA Ent
110	pperegri	Uni of Glam	MAPD
122	cevans2	Coleg Sir Gar	BA Ent
250	ggeorge	Pontypridd College	BA Ent

3.4.2 Reasons for staff printing

When interviewed, a Coleg Sir Gar tutor explained that the printing was done in order to supply on request a hard copy of the materials to students. Two reasons were put forward: firstly the poor internet connections in that geographic area; secondly, the desire for the materials to be in front of the learner when completing the online tasks. This raised some questions about the usability of the structure of VLE which was designed to allow a switch between tasks, materials and resources windows without losing 'place'.

Another tutor, from Coleg Gwent, said that they printed a copy of the materials, had it bound and sent to all students. The reasons being that reading is difficult on screen, online display is not best suited for the reflective learning style, and poor internet connections.

4. Student preferences

Much of what has been learned so far has been based on interpreting the data generated by activity on the web server. To understand more about e-learners' behaviour, they were surveyed electronically: firstly about their reading and printing patterns, including whether they received printed copies from tutors; secondly, about their preference for delivery (similar to the survey of Rosa,

1999); and finally to gain any further feedback.

Section 1 used option boxes to indicate level of activity. Error checking was used to ensure data was collected.

Section 2 used a radio box matrix to rank choices. Error checking was used to

> 1. Reading the material
>
> Do you read the course materials on screen?
> Never
> Sometimes
> Regularly
> Always
>
> Do you print a copy to work offline?
> Never
> Sometimes
> Regularly
> Always
>
> Does your tutor supply you with a printed copy? Never   If I ask Each module

ensure only one first, one second and one third choice was made.

> 2.   Preferred   delivery   of   course materials
>
> Rank the course materials format in order of your preference:
> 1st choice
> 2nd choice
> 3rd choice
>
> Materials accessed in Blackboard
>
> Electronic files sent to you
>
> Printed material sent to you

Finally a multi-line text box allowed students to provide additional comments; these provided some interesting points which will be discussed later.

> 3. Any other comments you would like to make about the online course materials:

The sample of active students was contacted by e-mail linking them directly to a web-based form. The results were collected in the SQL server database and keyed by enrolment number. The enrolment number was then use to join the data to the student profile, eg age, award, college etc. Out of the 553 users in the

sample, 145 responded. The breakdown   of students was as follows:

Table 12 Sample distribution by course

Course	Sample	Responded	% Response
Associate Student Scheme	69	1	1.5 %
BA Enterprise Award	215	88	41 %
Foundation Business Administration	95	11	12 %
MA Professional Development	173	43	25 %
Combined Studies	1	1	100%

Table 13 Sample distribution by age

Age Group	Sample	Responded	% Response
Under 25	51	15	30 %
25 - 35	152	40	26 %
35 - 45	191	51	27 %
45 plus	135	35	26 %

Table 14 Sample distribution by institution

Institution	Sample	Responded	% Response
Bridgend College	31	7	23 %
Coleg Gwent	36	9	25 %
Coleg Sir Gar	123	29	24 %
Llandrillo College	33	5	15 %
Pembrokeshire College	20	3	15 %
Pontypridd College	14	0	0 %
University of Glamorgan	296	91	31%

The low response from the Associated Scheme is because students achieve accreditation for this scheme if they withdraw from the BA Enterprise but have passed the induction training. The high response from the combined studies is due to there being only one student in this category. A similar response rate was gained from each age group.

The lower response from Llandrillo, Pembroke and Pontypridd Colleges is reflective of the low or no time spent with the materials electronically in the VLE. However, there was no clear reason for low responses from Foundation and MAPD students.

The initial findings show that only a quarter always read online, with almost half never or only sometimes reading online. Similarly, just over half always or regularly printed

Table 15 Student reading and printing activity

Student reads online	Always	26 %
	Regularly	28 %
	Sometimes	43 %
	Never	3 %
Student prints	Always	36 %
	Regularly	23 %
	Sometimes	33 %
	Never	8 %

Looking at online reading and use of print version by age group indicates that proportionally there was little difference between age groups as far as online reading; although over-45s seemed unlikely to 'never' read online, the sample was too small to be clear.

Read Online by Age group
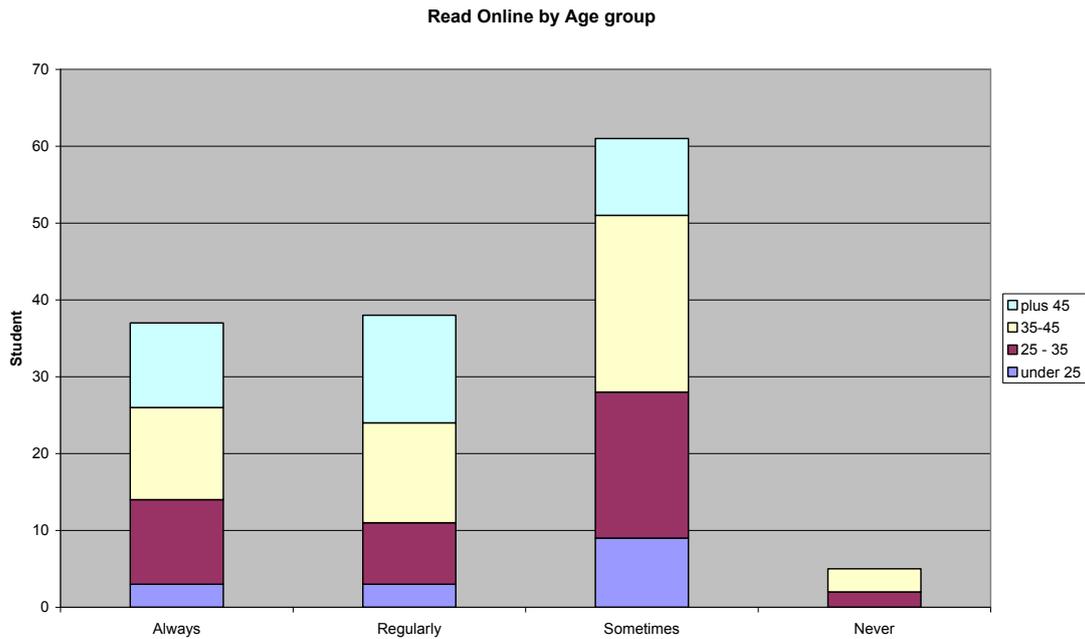
Almost 40% of e-learners were supplied with a print version of the content by their tutor. The distribution of this activity was fairly similar between the BA and Foundation degrees with around half never receiving a print version. In comparison, two-thirds of the MAPD students never received a print version.
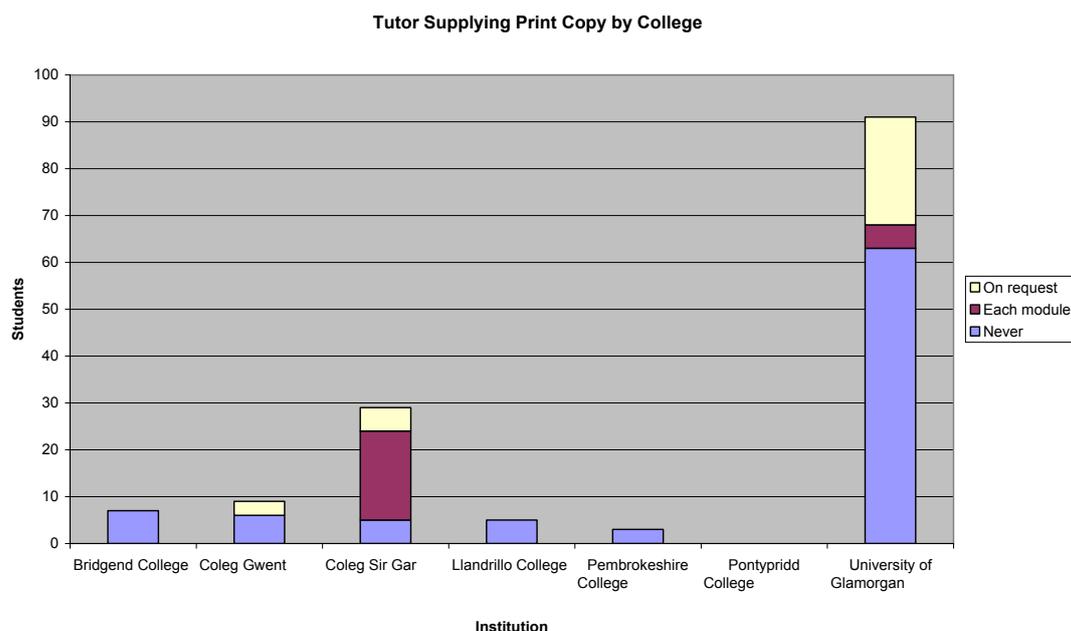
Tutor Supplying Print Copy by Award
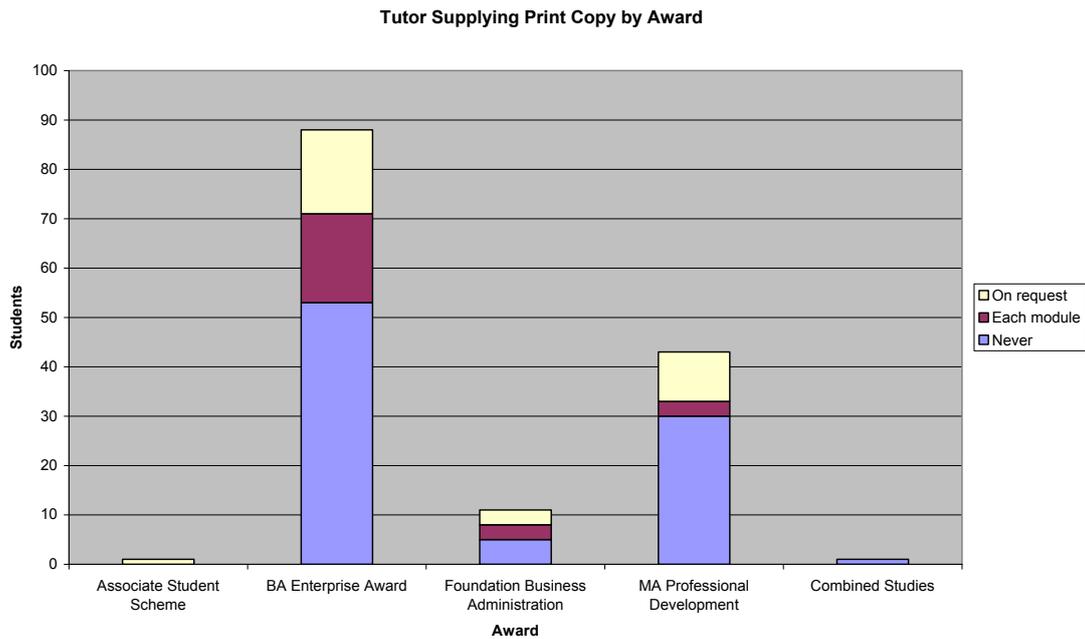
An analysis of which institutions were supplying printed versions reveals Coleg Gwent, Coleg Sir Gar and the University of Glamorgan supplied of their learners with printed versions on request. In addition, Coleg Sir Gar supplied most of its students with a printed copy of each module.

Tutor Supplying Print Copy by College

Combining the view of users who either printed regularly, always, or their tutor supplied a copy reveals that 77% of the users accessed a printed version of the materials.

The online reading pattern of this group of learners shows over half read online 'sometimes' and almost half 'regularly' or 'always'. This is a similar pattern to the overall reading trend with more of a bias towards only reading online 'sometimes'.

Table 16 Reading pattern of learners who obtained printed versions

Reads online and has print copy		
	Always	21
	Regularly	31
	Sometimes	55
	Never	4

In terms of learners who obtained print copies, the spread was fairly consistent at around the 80% mark with the under-25s being slightly less inclined to read online 'regularly' or 'always'.

Table 17 Age distribution of learners who obtained printed versions.

Age	Responded	Obtains print	%
under 25	15	10	67
25 - 35	40	30	75
35-45	51	38	75
plus 45	35	31	89

The first choice preference for delivery of materials of the overall sample shows that almost 2/3 of students prefer a web delivery as first choice while over a quarter would prefer a printed copy sent to them.

Table 18 First choice delivery preference

Web	86	60 %
Electronic file sent	18	13 %
Printed copy sent	40	28 %

The first choice preference of those students who either printed 'regularly', 'always', or whose tutor supplied a copy reflects a similar pattern. This is expected as 77% of users were in this group, the only change being a slight shift away from the preference for web delivery towards print.

Table 19 First choice delivery preference of users who obtained a print version

Web	64	58 %
Electronic file sent	14	13 %
Printed copy sent	33	30 %

The distribution of first choice preferences for the delivery of materials across age groups continued the pattern with twice as many requesting a web delivery over print.

Table 20 First choice preferences for the delivery of materials (across age groups)

Age	1st choice print	1st choice web	1st choice electronic
under 25	4	9	2
25 - 35	12	24	4
35-45	14	29	8
plus 45	10	21	4

The distribution of first choice preferences for the delivery of materials across awards again saw twice as many BA Enterprise

students requesting a web delivery rather than print. However, a larger proportion of MA Professional Development students preferred the web. Only slightly more of the Foundation students requested web delivery as first choice but this was a significantly smaller sample and therefore may not be as representative.

Table 21 First choice preferences for the delivery of materials (across awards)

	1st choice print	1st choice web	1st choice electronic
Associate Student Scheme	0	0	1
BA Enterprise Award	27	53	8
Combined Studies	0	1	0
Foundation Business Administration	4	6	1
MA Professional Development	9	26	8

4.1 Students' comments regarding printed materials

In addition to the statistical data, students were offered the opportunity to add comments. Feedback was given by 82 students, of which 45 gave some comment on the choice on printed materials. These comments can be grouped in to the following areas:

4.1.1 Reasons regarding access, eg:

Printed material is very useful when Blackboard is down or unavailable for maintenance.

Links are often very good however larger files take some time to download I would prefer these to be printed for me.

I can't always access the materials through Blackboard so printed materials are best

You cannot access a computer everywhere but you can a book

Because you are accessing the materials alone, you always have a slight concern that you have failed to find all the relevant material

4.1.2 Reading preferences, eg:

It is easier to read print information [than on screen] when there is a lot of it.

I find that the current materials are very hard to read in a continuous flow, mainly due to the subdivision into many individual pages

I prefer to read 'Hard Copies' as I find that by physically reading the notes I am able to highlight sections of material, and spread out many pages on my desk, which can then be cross-referenced with text books, etc.

The animations are great but not practical to print out the work to take away with you ... end up having to print each frame individually.... could they be put up in a comic book format with all frames visible at same time?

4.1.3 Making notes, revision, assignments, eg:

I find I don't take in all the information, however if I have a printed copy along side the keyboard I make additional notes

I always read the material online, but I also print off a copy so that I can read through offline when preparing for assignments.

Difficult to see the whole picture when accessing individual pages and unable to annotate with your own notes.

The first two years I did not print off material and used screen only. Third year printed material is helpful for revision.

4.1.4 Combination of print and electronic, eg:

Ideally a combination of access via Blackboard and printed materials sent out.

Core text books plus online materials works very well

Although I prefer to have a hard copy in front of me when I'm studying, the online course material is also very useful, especially the Flash illustrations which paint a picture better than words.

With electronic files and Blackboard I can choose what to print out

4.1.5 Time cost concerns, eg:

I have to print everything as I don't have the time to spend sat in front of the computer.

Make it easier to run off printed copy it's time consuming in the current format

I use a great of paper & ink to print out the course materials, I feel I must print it out so that I may keep referring to it when I need to, I also file in order and keep it in book form, this is expensive

From these comments it is possible to see that students have concerns over accessing and reading internet pages because of practical reasons such as eye strain, portability and the process of developing understanding by adding notes. Others make the suggestion that a combination of online and print would benefit learners while some raise the need to make it easier to obtain print versions and to reduce cost.

4.2 Other comments from students

Other comments made by students can be grouped into three main areas as follows:

4.2.1 Navigation and access, eg:

Would be better if it was made easier to get around and more user friendly. It took a while for me to get used to it. I know that some students still can't use it properly.

I think it is set out superbly as it is very easy to follow, can't think of any improvements which could be made

Would be really helpful to have more of the references for main and sub topics linked or available pdf files

Accessing discussion groups is very long winded - takes about 7-8 mouse clicks/screens to eventually get there. Very frustrating especially for each module!

4.2.2 Course design (academic), eg:

At the beginning of the course I felt the need to have the course materials up at all times but now I'm more confident they are read once then I look elsewhere [for additional information].

The way they are set out makes them easy to read.

I think the way they are is fine except I would prefer if each stage of the course materials for each module would outline what part of the assignment it relates to and also what tasks each part relates to.

Please get more e-books!

For the reading list for this module (change), there seemed to be more traditional books / articles listed than material available by e-learning. This is not what I would have expected - I do not have the opportunity to always come to a central LRC

The info in course materials, whilst user friendly, is vague.

4.2.3 Enjoyment, eg:

I found the course rather interesting, a lot better that I had anticipated, I did have my doubts at first about doing an online course, but it was rather enjoyable.

It's great and I enjoy doing it. It's very challenging

Excellent materials

Detailed information, references, etc which enhances other literature.

Very well structured

CPD course materials very good, useful and informative. Links are easy to use. Found experience very enjoyable, when time has permitted

Again the issue of access occurs and the issues raised here highlight the fact that the internet delivery can be difficult to navigate, the book perhaps being a more familiar provider for information for some. Others made specific comments regarding the way in which courses were set up and delivered while another group simply conveyed their satisfaction.

5. Conclusions

5.1 Time in the VLE

The findings indicate that 80% of users accumulate less than one hour a week with the course materials in the VLE with around two-thirds of all users acquiring less than 30 minutes. Analysis of users by course, age and college revealed a similar pattern.

5.2 Amount of content viewed for less than 20 seconds

Around 50% of the users viewed three-quarters or more of their content for less than 20 seconds and around 40% of users between half and three-quarters of their content for less than 20 seconds. Analysis of users by course, age and college revealed a similar pattern.

5.3 Average page view time

Around a third of users had an average page view of less than 20 seconds with around a quarter averaging between 20 and 39 seconds. No significant difference between groups of age, college, award or deviation by withdrawals.

5.4 Staff printing

Viewing evidence from both sets of data indicates that staff are printing and supplying over a third of students with printed versions of the materials and that this practice occurs mainly at Coleg Sir Gar and the University of Glamorgan.

5.5 Student preferences

While almost half of the students 'never' or only 'sometimes' read online, just over half 'always' or 'regularly' printed and 77% obtaining print either themselves or from the tutor. It appears that there is a distinct need for e-learners to have a printed version of the learning materials. However, twice as many learners expressed a preference for the delivery of learning materials via the web rather than over print, and age did not appear to be a factor in this pattern.

5.6 Student feedback

Feedback from students indicated that there are a number of concerns over accessing and reading internet pages because of practical reasons such as eye strain, portability, navigation and the process of developing understanding by adding notes.

Others make the suggestion that a combination of online and print would benefit learners while some raise the need to make it easier to obtain print versions and to reduce cost. A small group simply conveyed a positive satisfaction with the online learning experience.

6. Recommendations

6.1 Understand and use the appropriate medium

E-learning at e-College Wales is driven by its pedagogy rather than by technology. However, as this research shows, there needs to be a review of the way technology is used in e-learning specifically to understand and address the relationship between electronic delivery and printed text. Elearners.com defines e-learning as incorporating a number of technologies (audio, video, data and print), stating that 'Textbooks, Study Guides, Workbooks - Are still very common in online learning courses'[x] The inclusion of print as a valid e-learning technology suggests that it does best what it is designed to present, the written word. However, if electronic technology does not support the written word as well as print then there needs to be a better understanding of what this medium is best used for, eg collaboration, discussion, simulation, testing, tutoring, guidance and feedback.

The student-student interaction is key to Vygotsky's belief that "students learn from viewpoints of others in order to build a more complex worldview"[xi] and to Piaget's view that knowledge could be built or "constructed" on learner's prior experiences and knowledge and that peer-to-peer collaboration was more valuable than adult-to-child discussion (Conrad R.M., Donaldson J.A, 2004).

The suggestion that learners benefit more from being actively participating in the learning process, constructing understanding from their own knowledge acquisition and through student-student discussion lends constructivism as an appropriate pedagogical model for online study where online activity, independent researching and discussions between students plays an important part of asynchronous learning.

Innovations in this area are emerging with IMS Learning Design[xii] specification which moves away from describing and packaging content structures and focuses on learning activities which can use services such as chat, discussion and collaboration as well as content to achieve the learning outcome. Software vendors such as Learning Activity Management System, Blackboard™ and WebCT™ are already adopting learning design principles in response to the needs of the learning community. The shift from structuring courses around content to learning-outcome-based activities enables course developers to make the learning objectives transparent for the student and make decisions about the types of resources which can enable an e-learner to achieve them.

By removing the content-driven structure and forming an activity-based development process based on learning outcomes, e-College Wales's course developers could identify methods of learning appropriate for electronic medium where text-based material was only one option. This is in contrast to creating an 'online book' which encourages printing and offline reading. The output of this would be via the development of a VLE which conveys the learning structure and actively engages the student in the learning experience.

6.2 Understand and respond to learner needs

Overall it seems that the low use of the materials in their electronic format is largely accountable by the 77% of learners who are making use of printed versions. However, twice as many learners indicated a preference for web delivery over print. Perhaps then there is difference between the choice of medium for reading and the method of delivery. Interestingly enough only a small proportion would prefer an electronic file sent to them so this area of thought still requires some investigation to understand in what ways students prefer their learning materials to be delivered and which type of materials best suit which format. The e-learners' preference for web access but with a distinct need to read from print suggests a re-evaluation of how the two elements of access and use relate to each other.

For e-learning to truly meet the needs of online students, course developers must get

to know the students and establish quickly their likely needs by building learner profiles.

6.3 Construct knowledge from composite information sources

The study has shown that no one single piece of information can confirm exactly how students use the VLE. However, it has shown that by combining multiple information perspectives from multiple experiences it is possible to reveal patterns which can suggest tendancy for one thing over another. By translating the raw data into an information structure which can be looked at from different perspectives it is possible to start constructing knowledge about learners and the larning process which is essential for organisational decision making.

For this to work effectively, the learner profile should extend beyond mere preferences for reading materials or even simple demographics and should include special needs, deferral history, IT competency and their particular learning needs: "how they prefer to study, what they want from study, their long term goals".[xiii]

These learner profiles can be related to products or services such as Learning Resource Centre, tutorials, lectures, counselling, online resources, by activity logs such as attendance, assessment grades, library loans, helpdesk calls. This composite information model (see illustration) could be used to reveal patterns of activity for analysis.

Composite Information Model
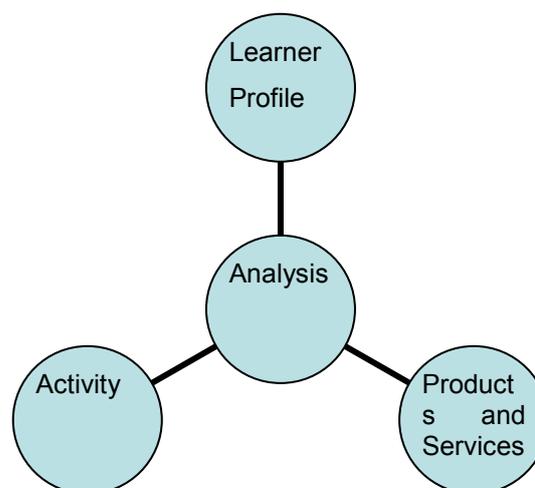
Analysis from this information model could be used to answer questions at 3 levels and provide the valuable evidence needed to inform the course development process and delivery models as suggested in Table 25.

Table 22 Example Feedback at 3 levels

Student	How am I performing?
	Which areas do I need to improve to get my grade?
Tutor	Which of my students require support?
	What teaching methods are more effective for these students?
Organisation	Do international students require a different support structure?
	What's the most cost effective way of improving retention and grades?

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