

Tools used in Learning Management Systems: Analysis of WebCT usage logs

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This paper investigates the use of tools within WebCT Campus Edition 4. Internal usage tracking data was analysed to determine the extent of use of WebCT tools within individual units of study at five universities, primarily Murdoch University. An innovative algorithm, using a geometric distribution, was used to categorise use of the tools. The research found that WebCT was heavily used in a teacher-centred mode, with the majority of use in provision of content to students, and in students reading messages from their lecturers. Tool use which emphasised student-centred learning was only apparent in a small number of cases. These results were relatively comparable with those from four other universities. The paper concludes with a discussion of the implications of the observed behaviour.

Keywords: WebCT, usage logs, Learning Management Systems

Introduction

Web-based Learning Management Systems (LMS) have been available for approximately ten years. These systems combine the ability to manage student access to content with management of results. They also provide numerous tools through which students can interact with online content, their lecturer and other students. WebCT and Blackboard have been the pre-eminent LMS suppliers, and they have recently merged, as part of a maturing of the online learning environment over the last decade.

While initial proponents envisaged a learning environment without face-to-face contact, the majority of university online learning use is as a supplement to traditional face-to-face teaching (Harris, Yanosky, & Zastrocky, 2003), in what is called variously mixed-mode, blended or flexible learning environments (Lefoe & Albury, 2004). A survey of online units of study offered at Australian universities in 2002 (Bell, Bush, Nicholson, O'Brien, & Tran, 2002) indicated that only 0.8% of 63,468 units of study¹ offered online had no face-to-face component.

While it is clear that Learning Management Systems are widely used around the world "Millions of users at more than 3,650 clients in over 60 countries worldwide" (Blackboard, 2005), little is known of the extent to which the set of LMS tools is used. This research seeks to investigate the extent of use of LMS tools at five universities which use WebCT Campus Edition 4. WebCT maintains internal usage logs which record the date and time a user accesses a tool or content page. The author had previously used these logs as one source of data in research about how students interacted with a web-enabled Biology unit (Phillips, Baudains, & van Keulen, 2002). An automated script was developed to easily access the comprehensive data available in the usage logs, and analyse the behaviour of individual students.

Other work looking at the analysis of automatically recorded system data is relatively rare. Lowe and Koppi (2005) used usage logs to identify WebCT courses which had high levels of student activity, and interviewed their designers in order to identify exemplary practice. This information was subsequently used for professional development. Other researchers (Judd & Kennedy, 2001; Kennedy & Judd, 2004) have explored the use of audit trails to analyse the use of multimedia medical courseware.

Learning Management Systems and pedagogy

At the time that Learning Management Systems were first developed, there was a significant, pre-existing body of literature, based on social constructivism, about appropriate ways to engage students in learning online. See, for example, Harasim, Hiltz, Teles, & Turoff (1995) and Collis (1996). Some systems, such as Virtual U, developed at Simon Fraser University, were designed around this approach.

On the other hand, many initial LMS developments were derived from a distance education model, a teacher-centred, transmissionist approach. The world-wide web was seen as an alternative and more flexible delivery method than paper and the postal system. WebCT was developed from this perspective by a computer scientist (Goldberg, 1997), with much of the early development done by students in projects. When the author initially investigated both Virtual U and WebCT in 1997, he was concerned about the pedagogical implications of the design of the system. Virtual U, while designed from a social constructivist perspective, was a relatively immature product at the time. However, WebCT, whose interface encouraged a focus on delivery of materials, had a rich toolset which permitted student-centred learning activities to be developed.

This rich toolset, and the responsiveness of the developers, led to explosive uptake of WebCT in the 1990s. However, while early marketing efforts focussed on the rich toolset, there was an underlying message that online education was all about delivering materials to students. A change in marketing focus has taken place in the last few years, with both WebCT and Blackboard claiming that they facilitate student-centred learning. For example, *“Using WebCT Campus Edition’s rich feature set, instructors can facilitate group-centric learning, personalize content and activities for students, and positively impact learning outcomes.”* (WebCT, 2006).

The impact of the architecture and interface of LMSs on pedagogy has been discussed, largely informally, at conferences and in online forums over many years. See, for example, a recent discussion on the ITForum list (<http://www.listserv.uga.edu/cgi-bin/wa?A1=ind0607&L=itforum>). It was the author’s belief that online courses could be developed from a student-centred perspective because of the rich toolset available. However, others have argued that LMSs have forced them to ‘dumb down’ their teaching.

A centralised Flexible Learning Initiative (<http://www.murdoch.edu.au/admin/cttees/flic/>) at Murdoch University focussed on making existing print-based resources available online and had led to wide uptake of WebCT (Phillips, Cummings, Lowe, & Jonas-Dwyer, 2004). However, a suspicion arose that WebCT was being used mainly to deliver content to students, with little use of the interactive tools.

Method

The research question was “To what extent are the various WebCT tools and functions used in individual units of study at university? The outcomes of this research could also be used to explore whether the LMS influences pedagogy. It might also be used to confirm or dispel WebCT’s claim that their product is student-centred. This research can be classified as Boyer’s (1990) Scholarship of Integration, connecting knowledge and discovery into larger patterns and contexts.

It was clear that the WebCT usage logs could be used to answer these questions. However, the script referred to in the introduction analyses only a single course at an individual level. The Tool Use product developed by Peter Love (<http://www.netkno.com/soft/toouse/>) was considered, but it analyses global use of tools across an entire WebCT installation, and the research question sought to break this down by units of study.

The work described below was prototyped by running the existing, unit-based script across all active WebCT courses, and aggregating the total use of each tool for each course. Excel was used to join this data with enrolment data in each course to calculate an average use per course of each WebCT tool.

Algorithm

This section describes the development of the algorithmⁱⁱ used to analyse the WebCT usage log data described in this paper. WebCT Campus Edition 4 (and earlier versions) records internal usage logs for each student in each course. A folder exists for each student in the course. A log file in each folder records the username, the location in WebCT, the type of tool used and the date and time. Each item is separated by a comma. The example below indicates that a student with user ID 19900912 (item 1) accesses a page of html content in a Content Module (item 2), which is generally classified as ‘Notes’. This occurred on the third of March 2001 at 18:58.

19900912,mainlabs/cells/N265_cells_answers.html,Notes,03/03/01 18:58

WebCT records the use of many tools. The names and descriptions of each of the tools referred to in this paper are listed in Table 1.

Table 1: Names and descriptions of each of the tools referred to in this paper

Name	Description
Home Page	Navigating to the Home Page
Content Page	Navigating to a page of unit material in a Content Module
Articles Read	Opening a Discussion forum article
Original Posts	A message posted into a new discussion forum thread
Follow ups	A follow up message posted into a discussion forum thread
MyGrades	Use of the MyGrades tool to display student marks
Assignment	Use of the Assignment Dropbox tool for electronic submission of assignments
Quiz	Use of the Quiz tool
Calendar	Use of the Calendar tool
Mail	Use of the Mail tool

The analysis tool processes each course and counts the number of times each WebCT tool is present in the logs for all students in that course. This provides an aggregate usage of each tool in each course. The number of folders corresponds to the number of students, so it is easy to calculate an average use per student of each tool in each course.

An example of this data is presented in Table 2ⁱⁱⁱ, showing the average use of each tool by students in that course. For example, course AIS180s1 had 114 enrolled students, and these students accessed the WebCT Home Page 56.9 times on average.

Table 2: Example of averaged raw data extracted from the usage logs for each course

Course	AIS180s1	AIS181s2	AIS201s2	AIS205s2	AIS274s2	AST258s2	BIO103s1	
Number of students	114	56	30	44	85	19	284	
Average accesses per student	Home Page	56.9	152.0	69.0	29.0	38.7	80.5	134.5
	Content Pages	10.7	92.7	13.6	4.2	4.9	10.5	25.8
	Articles Read	0.1	125.0	0.1	0.1	1.7	3.5	17.6
	Original Posts	0.1	0.7	0.1	0.0	0.1	0.3	0.8

Because Murdoch has hundreds of courses, it is difficult to detect overall trends from this type of data. However, this level of aggregation can be useful for analysing and comparing the characteristics of individual courses.

A common procedure in statistics to detect overall trends is to group the data into categories of use, typically quartiles or deciles (four or ten categories). However, when an analysis by deciles was carried out, most of the usage clumped into the bottom 20%, with little representation in the other deciles. That is, the arithmetic progression used to generate the deciles resulted in too little discrimination between the categories. Therefore, a geometric progression based on powers of two was used as the method of categorising the data. Average use per student of a tool >0 and ≤ 1 is put into category 1; average usage >1 and ≤ 2 is put into category 2; category 3 is >2 and ≤ 4 , etc. A consequence of this choice is that the lower categories correspond to a relatively narrow range of average use, while the higher categories correspond to a much wider range of average use. Because tools in many courses have zero usage rates, a special category 0 was also created.

The data resulting from this categorisation is shown in Table 3. The Home Page row can be interpreted as: there was one instance where the average hit rate per student was less than or equal to 1, one instance

between 1 and 2, and 21 instances where the average hit rate was between 4 and 8. In terms of the Content Pages row, there were five instances where Content Pages were not accessed at all. The geometric distribution provides a relatively even discrimination between categories: Home Page use is biased towards the higher categories, Content Page use is fairly evenly spread across categories and Articles Read cluster towards the lower categories.

Table 3: Categorisation of the raw data according to a geometric progression

Range	0	>0 ≤1	>1 ≤2	>2 ≤4	>4 ≤8	>8 ≤16	>16 ≤32	>32 ≤64	>64 ≤128	>128 ≤256	>256
Home Page	0	1	1	1	21	25	72	103	80	29	6
Content Pages	5	18	26	38	64	79	44	44	18	3	0
Articles Read	8	144	15	28	32	27	27	26	18	12	2
Original Posts	8	306	10	10	0	0	1	2	0	0	2

A perl script was developed to automate this algorithm across any selected WebCT courses. It is freely available to the WebCT community under a Creative Commons licenceⁱⁱ. Input options to the script enable subsets of users and subsets of available courses to be selected.

There are several shortcomings in the data which is logged by WebCT:

- While student data is cleared every time a course is reset, WebCT Designer data is retained and accumulates over years.
- From some time in 2001, WebCT stopped recording designer use of any tools except Home Pages.

Therefore, the usage tracking data contains an over-representation of designer hits on home pages, and an under-representation of hits on other tools. These factors are unlikely to affect the outcomes of this work.

Results

Results are presented first for Murdoch University in 2006, then as a trend over three years and then as a comparison across the five universities in this study.

Murdoch University 2006

Data from semester 1, 2006 reveals that WebCT was accessed 7,630,530 times by 33,541 student seats (students in units). This corresponds to 11,652 individual students in 385 units of study. This is 94.6% of Murdoch's 13,308 coursework students. It is clear that WebCT is widely used at Murdoch and it impacts on the majority of students. However, which tools are most widely used? This data is shown in Table 4, which lists the total usage of the most commonly used tools, together with their average use per course. A number of other tools were recorded as being used, but their use was very low, and they have been excluded from this study.

Table 4: Descriptive statistics of the most widely-used WebCT tools in Semester 1, 2006 at Murdoch

	Total # of hits	Mean # of hits/course
Number of students	33,541	87.1
Home Page	1,788,215	4644.7
Content Pages	975,885	2534.8
Articles Read	3,588,333	9320.3
New Posts	12,308	32.0
Follow Ups	36,082	93.7
MyGrades	148,987	387.0
Assignment	57,713	149.9
Quiz	188,507	489.6
Calendar	50,951	132.3
Mail	32,291	83.9

Table 5 displays tool use data derived from semester 1, 2006, using the geometric categorisation. Each row will be discussed separately. Since the Home Page is the normal point of entry to WebCT, leading almost exclusively to other tools, it is understandable that the majority of students would access the Home Page. In fact, only nine courses were not accessed at all. Of the others, in 12 courses Home Pages were accessed more than 128 times on average, while the largest category (106) was accessed from 32–64 times. Similarly, access to course materials through Content Pages was high and relatively evenly distributed. However, Content Pages were not used at all in 69 courses. These were from areas where staff provide content to students through other means than HTML, for example by downloadable Word and PDF documents. It is, however, apparent that WebCT is used extensively for delivery of content.

Table 5: Distribution of average usage rates of most widely-used WebCT tools for Semester 1, 2006 at Murdoch

Range	0	>0 <=1	>1 <=2	>2 <=4	>4 <=8	>8 <=16	>16 <=32	>32 <=64	>64 <=128	>128 <=256	>256
Home Page	9	0	5	8	22	50	92	106	81	12	0
Content Pages	69	13	10	21	45	64	55	78	29	1	0
Articles Read	95	18	13	17	27	34	46	64	36	25	10
New Posts	114	242	19	9	0	1	0	0	0	0	0
Follow Ups	132	190	37	16	8	1	1	0	0	0	0
MyGrades	244	3	5	11	59	44	19	0	0	0	0
Assignment	346	0	0	5	6	7	10	7	4	0	0
Quiz	330	7	2	6	7	12	12	6	3	0	0
Calendar	86	143	96	41	13	4	2	0	0	0	0
Mail	333	11	10	7	9	8	5	2	0	0	0

WebCT distinguishes three types of activity within the Discussion Forum: reading articles, replying to articles in a thread (Follow Ups) and composing articles in a new thread (New Posts). Articles were read in 290 courses (75%) and there was a relatively even spread of usage patterns. In 10 courses, students read on average more than 256 messages each. The median value was for students to read between 32 and 64 messages. Students have a strong appetite to read messages on the Discussion Forum.

Students contributed new discussion threads in 271 courses, but in all but 10 courses, there was an average of less than one new post per student. In only one course did students contribute more than 8 new messages. In a course designed from a social constructivist perspective, learning activities would typically require a *minimum* of one message per week per student. In an active class, much higher posting rates would be expected. Table 5 shows that only one course came close to this figure. Overwhelmingly, students do not seem to contribute in large numbers to the Discussion Forum. However, the ten courses with moderate rates of posting (>2 posts per student) ranged across all areas of the university, with class sizes ranging from 7 to 199, and from second year to Master's level.

It is apparent from Table 5 that substantially more articles are read than posted. This is logical, in that in a class of N students, each message posted ideally should be read by $N-1$ other students. In a class where each student posts M messages, the theoretical maximum number of articles read is $M \times N \times (N-1)$. If not all messages are read, or if the class is divided into self-contained groups for discussions, then the number of articles read will be less than this number, assuming there is no re-reading of articles.

The average number of articles read per course was 9,320.3 (See Table 4). The average number of new articles posted was 32 per course, and the average enrolment in each course was 87.1. The theoretical maximum number of articles read should be $32/87.1 \times 87.1 \times (86.1)$, i.e. 2,753.1. However, the average number of messages *actually* read was 9,230. Assuming that each message was only read once by each student, and understanding that WebCT CE4 does not currently record messages posted by course Designers, one can deduce that lecturers contributed the majority of messages read by students.

Follow Ups to existing threads were more common than New Posts, with students in 63 courses contributing more than one response on average. The average number of Follow Ups per student over all

courses was approximately one. However, more than eight responses were posted per student in only two courses. Once again, students seem to be passively reading what is posted, without contributing their own ideas or engaging in discussion about unit content.

The MyGrades tool was used substantially in approximately one third of cases. This tool has been promoted within the university as an efficient way for lecturers to inform students about their results. The assignment submission tool is only used in 39 courses, primarily in the School of Information Technology, because the university is still grappling with issues related to electronic marking. The Quiz tool is used in 48 courses, largely to support a suite of information literacy courses. However, the heaviest use is for ongoing formative assessment in several science units.

The Calendar tool was used to some extent in 156 courses. However, it was used more than eight times in only six courses. The nature of the Calendar tool is that it should be used at least weekly, so average use should be 13 per student in all courses which use the Calendar tool. It is possible that the Calendar tool was not well populated by lecturers, and students stopped visiting it when they found it contained no useful information. Anecdotal evidence is that lecturers find it tedious to enter data into the Calendar. The Mail tool was used relatively infrequently, but it is used quite heavily in those courses which provide this tool. These courses tend to use the Mail tool instead of the Discussion Forum tool, reinforcing the view that WebCT is used primarily as a mechanism for teachers to communicate to their students.

Trends in Murdoch usage data

The approach described in this paper was first developed in 2004, and three years of data are therefore available for analysis of trends in usage. To enable data to be compared across the different numbers of students and courses active in each year, an average use per student was calculated for each tool, as shown in Table 6. That is, the total number of hits of each tool (Table 6) was divided by the total number of students in courses for each tool.

Table 6: Average tool use per student during the years 2004-2006 at Murdoch University

Range	2004	2005	2006
Home Page	41.1	43.2	53.3
Content Pages	15.7	23.1	29.1
Articles Read	24.2	62.8	107.0
New Posts	0.3	0.3	0.4
Follow Ups	0.4	0.5	1.1
MyGrades	2.2	3.8	4.4
Assignment	1.2	1.1	1.7
Quiz	2.0	4.4	5.6
Calendar	1.0	1.3	1.5
Mail	0.9	0.7	1.0

Table 6 shows that average use of the Home Page per student has increased since 2004. In other words, students are visiting WebCT more often. This implies that they are looking for, and perhaps finding, more valuable information.

The situation with respect to Content Pages is more complex. Use of this function has clearly risen since 2004. However, analysis of the geometric distribution of use of this tool (cf. Table 5) across each year showed two different trends. Figure 1. displays the variation in use visually, where each distribution has been scaled as a percentage of the total. It is apparent from the left side of Figure 1, that substantial numbers of students did not use Content Pages at all in 2005 and 2006, and this number had increased markedly since 2004. This could be because their lecturers are no longer maintaining both Word and HTML versions of course materials, and instead are letting students download Word or PDF documents. However, other students, towards the right of Figure 1, are making heavier use of Content Pages.

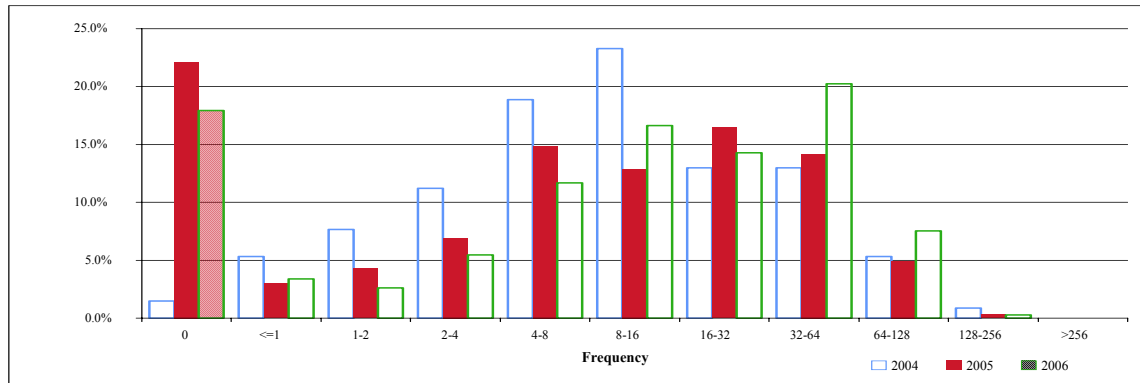


Figure 1: Trends in content page usage since 2004

Table 6 shows that there has been a fourfold increase in students reading articles on the Discussion Forum since 2004. However, usage patterns for Original Posts are largely unchanged, implying that the Discussion Forum is used increasingly by lecturers to post notices to students, rather than for learning purposes. There has been some increase in Follow Up posts by students, indicating that students are starting to engage in a dialogue with their teachers and other students.

A doubling in use of the MyGrades tool has occurred since 2004, as it has been promoted by the university. Similarly, Quiz use has almost tripled since 2004. However, use of the Assignment, Calendar and Mail tools has been largely unchanged over the period.

Comparison across other institutions

It is possible that Murdoch's patterns of use of WebCT tools is idiosyncratic, and other institutions have very different patterns of usage. This possibility will be explored in this section by comparing patterns of usage across several institutions. The webpage describing the course usage analysis scriptⁱⁱ asks users to contribute their data as part of a benchmarking exercise. To date, four institutions have contributed data. Three are Australian, referred to as Oz1, Oz2 and Oz3, while the third is from the US, referred to as US1.

Oz1 was established in 1966. It is a comprehensive, city-based university with over 15,000 students, four faculties and 20 schools. Oz2 was established in 1967. It is a comprehensive, city-based university with over 30,000 students, one third of whom are postgraduates. Oz3 is a capital city-based former College of Advanced Education which gained university status in 1990. It has 10,000 students, three divisions and 10 schools. US1 has more than 7000 students in the southern United States. It is a regional campus of a state system university. US1 is known for its strong science/technology programs with local ties to NASA (aerospace) and U.S. Army research projects.

Table 7 shows the average number of hits of each tool per student, aggregated at each university over all courses. Overall, the trends are fairly similar at the different institutions. The average Home Page hits provide a measure of the overall intensity of use of WebCT. Murdoch's use is greatest, just ahead of Oz2, with Oz1, Oz3 and US1 indicating similar usage rates approximately two thirds that of Murdoch. The same ranking is apparent for Content Pages, with Murdoch students accessing online content at a rate 7 times that of US1.

In terms of the discussion tools, Murdoch students once again have the highest level of activity in reading forum articles. However, the rates of new messages and replies to threads are similarly low at each institution. The MyGrades tool is used most heavily at US1, with Murdoch second. The other Australian universities use the MyGrades tool less frequently. The US university is the highest user of the Assignment submission tool, which is used less frequently at the four Australian universities, with Oz1 being substantially lower. This is also the case for the Mail tool, with Murdoch using this tool much less frequently than US1. The Quiz tool exhibits an opposite trend, with higher usage rates at Murdoch, Oz1 and Oz2. Use of the Calendar tool is similarly low at all five universities.

Table 7: Average tool use per student at five different universities

University	Murdoch	Oz1	Oz2	Oz3	US1
Home Page	53.3	35.1	50.9	35.5	31.3
Content Pages	29.1	9.3	18.2	14.7	4.2
Articles Read	107.0	58.3	65.7	23.9	28.7
New Posts	0.4	0.3	0.4	0.3	0.3
Follow Ups	1.1	0.7	0.9	0.5	0.5
MyGrades	4.4	1.4	1.2	2.1	5.7
Assignment	1.7	0.3	1.0	1.5	3.9
Quiz	5.6	4.5	4.1	2.0	2.7
Calendar	1.5	0.5	0.6	0.8	2.0
Mail	1.0	3.2	3.6	3.5	6.5

Discussion

The research question that this work investigated was the extent to which the various WebCT tools and functions are used in individual units of study at five universities. Subthemes were the type of pedagogy in use at Murdoch, whether the LMS influenced the pedagogy and how well the use supported WebCT's claim that their product is student-centred.

The results clearly indicate that WebCT is heavily used at each university. Two tools are used extensively: Content Pages and the Discussion Forum – but the latter is used overwhelmingly for students to read information posted by their lecturers. The My Grades, Assignment Dropbox, Quiz, Calendar and Mail tools were used to a moderate extent, but others were used minimally.

Phillips (2004; 2005b) has identified four design dimensions of e-learning, based on the interactions that a student may have in a technology-supported learning environment, between student and student; student and teacher; student and resources; and student and computer.

The evidence at Murdoch University is that the interaction between student and resources is very strongly represented in the online components of the blended learning environment. There is little evidence of online interactions between students and other students, except in a small number of courses. There is however, evidence of interaction between teacher and student, with substantially less, but increasing, reciprocal interaction between student and teacher. No evidence is available from the data about the interaction between student and computer. The situation at the other three institutions studied is similar, but with even fewer student–student and student–teacher interactions.

It is not necessary, nor always feasible, for all four interactions to be present in a learning environment. Indeed, in a blended environment, student-teacher and student-student interactions are likely to take place face-to-face. Nevertheless, there is a strong and growing literature about effective educational practice, based on a broadly constructivist pedagogical philosophy, with a student-centred rather than a teacher-centred approach to teaching (Phillips, 2005a). The evidence here, on the other hand, points to a consistently teacher-centred online environment. Survey research by the Australian Technology Network universities (Platts, 2004) supports this conclusion, indicating that staff feel that a Learning Management System “*is efficient in making materials available to students; [and] enables teaching staff to give timely information to students*” (:4). This work also found that “*Most units offered via online learning do so only for purposes of information to supplement face-to-face teaching and learning. They use only about one-third of the capabilities that online learning systems provide.*” (:4).

On the face of it, this work confirms Cuban's (2001) finding that educational technology is being used to replicate existing practice rather than being used in new ways. This research is not able to determine whether face-to-face teaching practice has changed as a result of content being available online to students. Anecdotal evidence indicates that some staff *may* have changed their approach because there is now less need to deliver content to students in lectures. However, this work and earlier usage tracking work (Phillips, Baudains, & van Keulen, 2002) indicates a strong demand from students for more interactive content. They are certainly reading articles and viewing calendars, and, to a certain extent, they are posting and replying to

forum messages. However, there is also evidence (such as in the low use of calendars) that students are not finding what they are looking for in the interactive tools, because their lecturers are not using them well.

It is reasonable to ask why WebCT usage is like it is at Murdoch^{iv}? Three reasons can be identified.

The wrong message has been provided centrally

Murdoch's flexible learning initiative (<http://www.murdoch.edu.au/admin/cttees/flic/>) was predicated on a move from modes of delivery to flexibility of access, and this was embedded in the Murdoch strategic plan^v, with a performance indicator of 95% 'conversion' required by 2007. This initiative evolved into a focus on delivery of content, because a core task was to make existing print-based resources available online. A second, related initiative was the implementation of the iLecture web-based lecture recording system. Both of these initiatives encouraged replication of existing teacher-centred practice.

Inadequate staff development

When WebCT was first adopted at Murdoch (1998–2000) project funding provided staff development on both pedagogical and technical issues related to online learning. However, from 2001–2004 the University had no academic staff development position, and the focus of any professional development was purely technical. This period overlapped the flexible learning initiative, and, consequently, no guidance was available to staff about alternative pedagogical approaches to the use of WebCT.

Staff are time poor

The third reason that WebCT use has been teacher-centred is that staff are increasingly busy. They have no time to invest in learning new approaches which have been mandated centrally without any individual support or rewards. A related factor is that WebCT is too hard to use for many staff. The decrease in the use of Content Pages and the poor use of the Calendar tool indicate that WebCT corroborate this. Many staff resent having to learn HTML authoring skills, and the need to maintain duplicate copies of documents in both Word and HTML format is onerous to staff.

Conclusion

This paper has provided evidence that a teacher-centred pedagogy is in use at each of the five universities represented in this study, and there is little support of WebCT's claim that their product is student-centred. It is difficult to say whether it was the LMS or other factors which influenced the pedagogy adopted, but the fact that all five universities had similar usage patterns provides some evidence that users' perceptions of the functions of the LMS influenced their pedagogy.

It costs approximately \$A250,000 per annum to run WebCT at Murdoch, and it is prudent to attempt to make the best use of that investment. This appears not to be the case at present, where the major WebCT functions used (providing content and notices from lecturers) could be provided almost as well by an FTP server and email, at much lower cost.

Furthermore, the current use of WebCT is at odds with a key strategy of the educational goal of Murdoch's current strategic plan "*To provide a student-centred learning environment for all students*". While 'student-centred' could be interpreted more broadly than the concept has been treated here, it would be advisable for Murdoch, and other universities promoting student-centred learning, to reassess whether the way they are using their LMSs are consistent with their strategic directions. The same could be said of LMS providers, such as Blackboard.

This paper has shown that WebCT usage logs can be used to inform policy makers and educational development units about the success of curriculum improvement initiatives. They can also be used by educational designers and staff developers to identify courses with inappropriate use of tools, and to identify exemplary courses which can be highlighted to other staff.

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ⁱ The term 'unit of study' or 'unit' will be used to describe a semester long programme of study on a single subject. The term 'course' will be used to describe a WebCT instance associated with a unit of study.

ⁱⁱ A more detailed description of the algorithm and the software is available at
http://www.tlc.murdoch.edu.au/project/webct/tool_use_analysis.html

ⁱⁱⁱ Tables 2 & 3 display data from 2004, when the prototype analysis was performed with 339 WebCT courses.

^{iv} The research design did not allow closer analysis of the wider context at the other universities.

^v <https://www.murdoch.edu.au/admin/strategicplan/>