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ON-LINE LEARNING – AN EVALUATION

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Abstract:

After seven years of experience with parallel web and face-to-face courses, we present a review of how students in a predominantly traditional educational environment work with a web course. The objective of this review is to consider lessons learned on the presentation and performance of web courses.

1. Introduction

The increased availability of the **World Wide Web** and broadband networks has enhanced the ability to reach students who are not able to attend regular face-to-face courses for different reasons. While many universities are including on-line, Web-based courses in their curriculum and a few are providing wholly on-line degrees, most universities and their students still seem to prefer traditional, lecture-based course presentations despite the advantages of relaxing the space and time constraints of the traditional lecture format.

The authors of this paper have been teaching university courses on information and computer science for more than **30** years and started to adapt their previous face-to-face courses to interactive web courses in **2000**. These include undergraduate and graduate courses in data management, AI, neural networks and development of web applications. Course implementations have used **ColdFusion Mark-up Language** to be run on an **Adobe/Macromedia ColdFusion MX server**, **WebCT** and the open source **PHP 5** scripting language for running on a **PHP 5 server**.

These courses were designed under the assumption that the instructors should have no other contact with the students than by means of the built-in communication channels of the courses. These included e-mail, message boards, questions and answers board, and synchronous chat sessions. Most of the courses have been held for students of the University of Hawaii while the instructors were in Bergen, Norway. During the past seven years, these courses have been offered to more than **15** student classes.

The review presented in this paper is focused on the most recent experiences from one course, **Introduction to Dynamic Web Applications**. This course has been offered to **8** different classes from **2002** to **2006** at several universities and colleges in Hawaii and Norway. Using our experience with and the usage log for this course, our intent is to present a status for Web-based courses and to consider the advantages and problems that this presentation format has in relationship to traditional lecture-based courses.

2. Designing a web course.

The course, an **Introduction to Dynamic Web Applications**, has been developed with remote teaching in mind, and that the teacher would never meet the students during the course, thus requiring all communication to be within the on-line and Web environment. It is composed of **3** interrelated modules containing: 1) general information about the course, 2) the sessions and related teaching material, and 3) the communication tools. Student evaluation is done through a series of quizzes following topic sessions, supplemented by a self-proposed project consisting of the design and implementation of a dynamic web application. While the course has maintained its general structure, the topic content has been updated and the size extended from **10** to **15** sessions since the initial 2002 version.

The information module contains links to **13** different topics with information about the course including components on assignments, FAQ, grading, literature, search engine, software, tests, virtual classroom (pictures of students and instructor) etc. The information components are meant to provide general information sources about how to work with the course.

The session module contains **15** sessions with text, illustrations, live examples, session topic tests and assignments related to the course project. The tests appear at the end of each session while assignments are given in sessions **4**, **7**, **10** and **15**. Each session is opened at pre-set dates, usually each Monday morning. Both tests and assignments are mandatory. The deadline for responding to an assignment was **2** weeks after announcement. The system was set such that a student could not get access to any session before it has been opened and assignments and tests of previous sessions have been uploaded or passed.

The communication tools included e-mail, chat sessions, message boards, question & answer board and individual progress reports. Chat sessions have been organized for some classes, but not all.

Finally, the course system included a set of registration or log points. Each time a course user passed a log point, an internal identification, time, point location and which location referred to the present. These records were saved for future user activity analyses and are the basis for the analysis in this paper.

3. Gaining web course experience – a comparison of the class of 2003 and 2006.

As noted, our focus course, an **Introduction to Dynamic Web Applications**, has been offered each year since 2002. The presentation starts with a retrospective description and continues with a more detailed analysis of the users activities in a course class of **spring 2006**. Comments are also included relating our experience with this course to both other Web courses and our lecture-based courses.

A description of time trends in use of this course must be limited for several reasons. Important is the fact that the course has been adjusted and improved both in content and size over time. Second, the students' access to technological resources has changed rapidly in the last **3-4** years. A simple comparison of students completing the course **Introduction to**

dynamic web applications in 2 classes for undergraduate students, one class in **2003** with a **10** session version and a second in **2006** with a **15** session version of the course can be illustrative.

The **50%** increase in the number of sessions does not reflect a corresponding increase in content rather that the material has been presented in more detail.

The following **Table A** summarizes the experience:

Table A: Comparing 2003 and 2006 classes

Class	Sessions	Students	Visits	emails	Log records
2003	10	20	1774	443	12314
2006	15	15	1028	316	6430

The explanation for the decrease in number of attending students is an administrative change in maximum class size, and not a reduced interest for the course which was filled in both years.

The number of visits to the course site per student was higher in **2003**, and considering the number of sessions, a marked difference appears in the number of visits per student to each session which in **2006** was almost half, **5** visits, the corresponding number, **9** visits, in **2003**. There are several possible reasons for this observation. First, the **2006** class had better resources for copying the course content to their local environments. A more likely reason is that the **2006** class had a higher knowledge of working on the net and therefore less need for frequent returning to the course than the **2003** class.

It is noticeable that the number of passes of log points per student was significantly different in the 2 classes. This fact can indicate a much higher self-confidence with respect to net working among the students of **2006** than those of **2003** class.

The e-mail contact with the instructor was high and about the same per student in both classes. Assuming that e-mails saved in the instructor's mailbox are about equally distributed between students' inquiries and instructor's responses, each student had in average been writing 10 inquiries and getting 10 responses from the instructor during the course. Considering that the bilateral e-mail contact is a substitute for the face-to-face communication between instructor and each student, the web course seems to have more extensive teacher-student communication than most teachers experience after lectures and in office hours.

4. Logging web student activities - The 2006 Class

As already mentioned, this study was based on data automatically recorded by the course system. A **record** reflects a call for one out of the almost **1000** script files contained by the course system. The **134** scripts considered to represent the most essential parts of the course were selected as **recording (log) points**. The time between the **2** consecutively recorded points is named **interval time**.

The course system was designed to permit entrance only through the login page, i.e. bookmarks to internal parts of the system do not work. The login validation script was therefore used to record successful **visits** to the system.

Unfortunately, a recording of the end of a visit is impossible since a user can jump to another application or turn off his computer at any point. This implies that it is also impossible to exactly measure a user's **visit time** and the time of the last interval. In this study, the last interval time is disregarded, and the total visit time is an estimated minimum visit time, i.e. the visit time if the visitor left the course immediately after passing the last recording point of the visit.

4.1 What do the students return to most frequently?

As already explained, the course system contains 3 modules. Since each requires both resources to maintain, store and modify, a starting point for an investigation is to ask if these modules were used and how frequently.

Table B: Number of log records by modules

Modules	Number of log records
<i>Communications</i>	233
<i>Information</i>	2539
<i>Sessions</i>	3658
<i>All modules</i>	6430

Table B shows how the **6430** logged records were distributed to the modules. As may be recalled, the information module provided components with information about the use and content of the course. The high frequency of records logged, **2539** records, in this module, certainly indicates the use and justification for inclusion of this information in the course system.

Communication activity

The frequency of log records is of course depending on the number of recording points in the respective modules. In the communication module, one single recording point only was embedded. This point was referring to the use of the progress report feature. The other features have had a low usage previously and were not logged for this class. The **233** records of Communication module all referred to the call for an individual progress report, which corresponds to an average of **1** call for each student to this service per session. In addition,

there were **319** email messages exchanged estimated to about **10** requests from and **10** responses to each student during the course.

In retrospect, more recording points should have been left also in the communication module for this class to enlighten the (non-) usage of the other communication channels.

Referencing course information

Table C shows the logged information records for the **14** components included in this course. The Welcome section tops the list since it is very close to the records for the login recording point. The explanation of difference between the Visits and Welcome is that **9** visits were aborted before the Welcome recording point was passed.

Table C: Number of log records by information components

Information component	Number of log records
<i>About</i>	119
<i>Assignments</i>	345
<i>Calendar</i>	169
<i>Classroom</i>	105
<i>Curriculum</i>	63
<i>Examples</i>	86
<i>FAQ</i>	66
<i>Grades</i>	291
<i>Images</i>	54
<i>Links</i>	35

<i>Literature</i>	45
<i>Search engine</i>	56
<i>Software</i>	86
<i>Welcome</i>	1019
<i>All records</i>	2539

As expected, among the remaining components, the most important with information for completing the course, i.e. Assignments, Calendar and Grades were frequently visited. Surprisingly, the Virtual classroom (Classroom) also had a high visit frequency. The voluntary contribution to this picture gallery of the students did not contain more than 6 of the 15 students of the class. The contribution of pictures has decreased from one year to the next, and this component was planned to be dropped. The visit rate indicates, however, that it should be continued also in future versions, maybe with a better promotion.

Information on external material as represented by Links and Literature components had low visit frequencies indicating that the course should assign more attention to these, and makes the students explore also material outside the course. This can probably be done by extending the quizzes to contain questions from mandatory readings.

Among components which should be considered rewritten or dropped because of low visit frequencies are information components on Curriculum, FAQ, Images (how to copy illustrations) and Search engine (how to retrieve locations at which specified topics were discussed).

Session activity

Table D exhibits visits to sessions and session components. These can be considered as the counterparts to the face-to-face lectures with material handed out. Each session contained **3-4** interrelated components including a Text, the 'lecture' delivered orally in a face-to-face course, with hyperlinks to the other related components. All sessions contained illustrations, here called the Images, and live Examples. Four sessions also included specific Assignments, related to the course project. It is obvious that the visits to the Assignments component dominate those sessions.

From the recorded visits to the text section, we can make an interesting, and maybe alarming, observation. The visits to the sections except Assignments tend to decrease during the course. In Session 9, there are **2** live examples on the use and construction of internet agents which were not visited at all. In Sessions 13 and 14, the number of visits to the live Examples were also disappointing low. The explanation can be that the individual course projects which are being developed from Session 4 dominated student interest and attention. The students may find it difficult to utilize new features and methods learned in the late sessions since so much has already been finished on their project. Rather than trying to introduce new methods, the students concentrate on refining the application of the methods they started to apply in the first part of the course...

Table D: Number of log records by sessions and session components

Sessions	All components	Assignments	Examples	Images	Text
Session 1	275		66	81	128
Session 2	231		47	81	103
Session 3	209		28	108	73
Session 4	712	409	38	151	114
Session 5	170		21	71	78
Session 6	121		11	60	50
Session 7	450	309	22	58	61
Session 8	120		21	40	59
Session 9	77			30	47
Session 10	760	379	24	288	69
Session 11	82		11	23	48
Session 12	52		12	5	35
Session 13	45		4	17	24
Session 14	55		5	16	34
Session 15	299	206	19	22	52
All records	3658	1303	329	1051	975

There seem to be two options for future versions of the course: 1. either to reduce the number of sessions to the original **10** or leave more time for finishing the course projects, or 2. to give

particular credit to use of methods introduced in last sessions in the preparation of the projects.

No recording of the session tests has been implemented because all students were required to take and pass each test and the results were recorded as part of the final grades. If a student did not pass a session test, i.e. obtain at least **6** out of **8** correct answers for all except the final session in which **21** out of **28** correct answers were required, he could repeat the test as many times as needed to pass the test. The questions were each time randomly selected, and presented in a random order. Recording the number of test trials would, however, be interesting additional design information for future courses.

4.2 How much time do the students use online on the course?

The course is a **3** credit undergraduate course, and an interesting question is how much time do students spend on the web course on-line. This time may be considered as the counterpart of lecture time in a face-to-face course. What is spent offline reading, studying and working on the course project cannot be answered by the recording done by the course system. With current technology, it should be expected that students copy the course content to their own computer for offline use as well as printing hardcopies of the whole or parts of the course.

The approach used to get some estimate on time usage is to take advantage of the recording points in the course. At each recording point the internal student identification is recorded as well as a time stamp. Since a student can only enter the course and start a session through the login entrance, all her timestamps before she makes a new entrance belong to the same session.

No reliable method exists for timing the exit from a session. As explained above, we have used the time interval from the last recorded timestamp of a visit and the entrance timestamp as a minimum estimate of the session time being well aware that the last leg of the session path is not accounted for. Instead of making uncertain assumptions about the students' behaviour at the end of a session, we have rather reported the factual registrations as minimum estimates of time spent.

As discussed above, the number of student visits, or sessions, to the course was **1028**. Some of the sessions have only timestamps for entrance because the visitors went on only to course locations which did not belong to the **134** recorded locations, or they may have been distracted from the course and never went on before their session registrations timed out.

The minimum total time on the course server spent by the students on the course was **237** hours **27** minutes and **41** second. Each student spent in average minimum **15** hours and **50** minutes online on the course.

The average minimum time spent per session was about **14** minutes with a large variation from sessions with no time recorded to those lasting nearly **1** hour and **50** minutes.

Even though these statistics refer to minimum estimates, the time students spend online this web course was obviously much less than the ordinary 2 hour lecture. The unanswered

question is whether the learning and inspiration of a seasoned lecturer compensate for the difference in time spent.

The next question also unanswered is of course if the web course gives the students a better basis for continue to work offline at home than the face-to-face course.

5. Conclusions

The material available from the web courses given is far from exhausted. The logs provide possibilities for comparison over time, between courses on different topics, and analysis of the students' typical paths through a course which all can contribute to improved web courses in the future.

However, already this limited study has generated some experience which we hope to take advantage of in future work and we finish this presentation with a few preliminary conclusions

This particular course has so far always been overbooked which we take as an indication for the need for web courses with their flexibility with respect to work time and location... A web course requires, however, students who are independent and have a fair amount of self-discipline, student who have not yet obtained this level are probably best served by traditional courses.

While students 5-6 years ago were struggling with net technology and access, today's students seem to have a background which permit them to focus on the course topic. The electronic communication we have with our students has an extent and a to-the-fact form which is both wider and better than we experienced in face-to-face courses.

Quizzes, course assignments and course project seem to be very important elements for securing successful results from a web course. We have graded the course work in different ways from grading of these elements to written exams, but the course projects always seem to be the single most important element for evaluating the students' performance in a web course.

From the experience of this course, we can see possibilities for improvements by introducing as much as possible of methodologies at an early course stage where the students can apply these in their course project, and finish the course with examples from which the students can obtain tips for polishing their reports.

The students should be provoked to read referred literature, and questions from the readings should be worked into the session quizzes.

The work with the log from this course indicates that more recording points should be embedded into the course to give a better picture of its usage.

We still hope that at we sometime shall be able to set up a well designed course experiment in which we can collect data for a realistic comparison between a web course version and a face-to-face course version for the same topic, and carry out an acceptable evaluation.