

QUANTITATIVE WEB-BASED TEACHING TOOLS FOR PROGRESS MANAGEMENT AND EVALUATION

Frode Eika Sandnes¹, Francine Hua-Li Jian²

Abstract ^{3/4} The general availability of the Internet and hypermedia technology has drastically changed the way individuals acquire information. The internet has also been embraced by many educators, although the use of internet technology in education is currently in an intermediate and incomplete state. There is uncertainty regarding how this technology is best put to use. This work focuses on a set of open tools that interface the teacher and the student, both in an on-campus scenario and in a distant learning scenario. The tools assist teachers in tracking and managing a large number of students' progress – measured in the rate of curriculum assimilation and success with exercises and coursework. Teachers get a continuous overview of the class situation and can take remedial actions. The administrative task of tracking and managing students' progress is greatly simplified. This may lead to improved coherence and consistency in student evaluation.

Index Terms— Internet, portal, student evaluation, student management, web.

ENVIRONMENTAL CONSTRAINTS

Teaching in the Faculty of Engineering at Oslo University College is predominantly based around traditional lectures and laboratory exercises. Students are evaluated using examinations, as the Norwegian department of education requires that all evaluations influencing the degree certificates issued by the University Colleges must be approved by an external examiner. Although desirable, it is impractical and expensive to cross-check coursework externally. It can also be difficult to recruit examiners to take on the laborious task. Consequently, assignments are generally not assessed externally and do not explicitly contribute towards the degree certificate. However, it is the general consensus amongst students that coursework is necessary for establishing sufficient motivation to work on the subject. Assignments are therefore made obligatory. All coursework must be approved in order for a student to be allowed to register for the exam. This is a cost-effective alternative that identifies the students that may need assistance or guidance.

A second constraint is the teacher-to-student ratio. The last five years have shown a steady increase in the intake of students to computer oriented engineering courses while the number of academic staff has remained constant. The

teacher becomes overloaded with responsibilities for preparing the course, lectures, laboratory exercises, student consultation and the management and evaluation of the obligatory assignment submissions. Management and evaluation of obligatory assignments are particularly monotonous and time-consuming tasks.

For first and second year courses, students from the years above can be used as teaching assistants, reducing the workload of the teacher significantly. However, it is generally not possible to employ student assistants for final-year courses as the majority of Norwegian University Colleges do not have the mandate to enrol postgraduate students.

SHORTCOMINGS OF THE TEACHING MODEL

The current teaching model does not appear to reduce the high failure rate amongst students. Generally, exam results appear to be biased towards the lower end of the scale. Further, there are too many students assigned to each teacher who leaves very little time for each student. To ease the workload of the teacher it is common to encourage students to work in groups and submit one assignment per group. This can be justified using the argument that it is important for engineering students to be exposed to teamwork as engineers work in teams. Frequently, the distribution of work within groups can be very unbalanced. Students that devote the least effort are not assimilating the syllabus as well as the active peers.

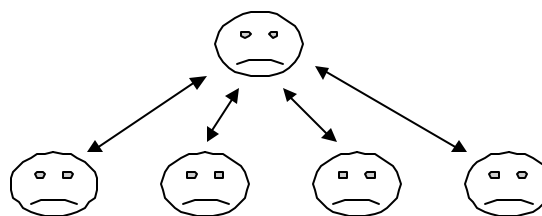


FIGURE. 1

ONE-TO-MANY TEACHER-STUDENT SCENARIO. THE INSTRUCTOR BECOMES THE BOTTLENECK WHEN RESPONSIBLE FOR MANY STUDENTS.

Some academic staff are involved in both teaching and research projects and they therefore have to multitask between the two. Seemingly meaningless and tedious administration tasks can be perceived as frustrating and thus

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affect the teachers' attitude towards teaching. Undoubtedly, attitude has a direct impact on teaching quality. Teaching quality affects the students' learning process which is directly measurable through the results of the examination. The administration in educational institutions harvests their funding as a function of the examination results. Funding determines the amount of resources available to the students, and there is thus a cycle of interdependent factors (See Figure 1).

OBJECTIVES

The objective of this work is to determine how web-technologies can be used to simplify the administrative and management tasks associated with running an engineering course. An obvious prerequisite for teaching quality is a

comfortable teacher. A teacher must not be overloaded with time-consuming and monotonous tasks. The aim is therefore to optimise the benefit-to-effort ratio in assessing and assisting students. A web based teaching framework can provide the mechanisms allowing the teacher to identify certain students that need assistance and guidance. This includes those students that would otherwise not seek assistance from the teacher. Statistics can also be used by the teacher to prioritise the students. We have come across several situations where students seek the teacher's attention when they actually do not need any assistance but are capable of working independently. As a result one should be able to increase the overall level of class performance by addressing the critical syllabus issues and weak students.

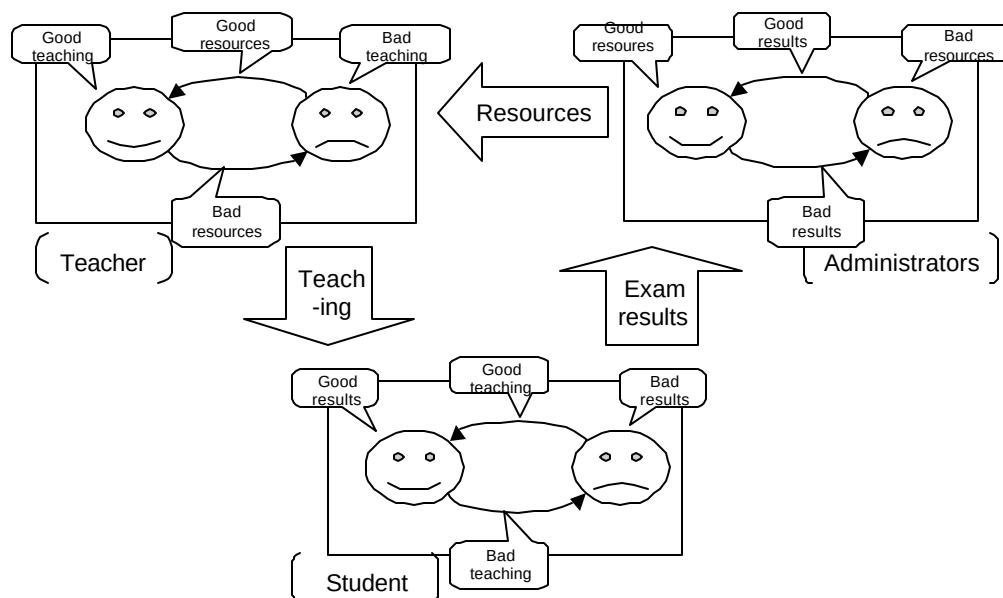


FIGURE. 2

THE RELATIONSHIP BETWEEN TEACHER QUALITY, EXAMINATION RESULTS AND FUNDING. QUALITY TEACHING DEPENDS ON RESOURCES, RESOURCES DEPENDS OF FUNDING, FUNDING DEPENDS ONE XAMINATION RESULTS AND EXAMINATION RESULTS DEPENDS ON TEACHING QUALITY.

STUDENT VIEWPOINT

This work is based on the following hypothesis: Students are classified into three groups, the *resourced students*, the *moderately resourced students*, and the *sparsely resourced students*. The *resourced students* are those who “always” perform well in exams, seemingly irrespective of teaching quality and methods. These students have the ability to work independently, readily acquiring and assimilating information. They “always” succeed and can be viewed as statistical outliers. The *sparsely resourced students* are those that seemingly always fail exams irrespective of teaching quality and the amount of resources allotted to their learning. This could be due to

extracurricular events, undeveloped study techniques or simply a lack of academic cultivation. This group can also be viewed as consisting of statistical outliers. The remaining group, the *moderately resourced students*, including the majority of the students, are affected by the teaching, the supervision and the allocated resources. This is the target group of the proposed approach. Note that the boundaries between the three groups are not distinct.

The reasons for unsatisfactory learning are usually insufficient effort from the student. This can be insufficient attempts at the assignments, poor preparation for the exams, no preparation prior to lectures or a combination of these. The average student needs a certain amount of guidance and “pressure”. It is the general consensus amongst students that

they need coursework in order to study. A student falling behind in a course is likely to violate average study habits. Some students may disguise the fact that they lag behind and create a façade in order not to lose face in front of the teacher and fellow students. It can be difficult for a teacher to identify such situations. Further, when dealing with a class comprising several hundred students it is not feasible to track the progress of the individual students. However, using a web based teaching framework, the intention is to approximate a one-to-one teacher-student scenario with a one-to-many teacher-student scenario (See Figure 2 and 3).

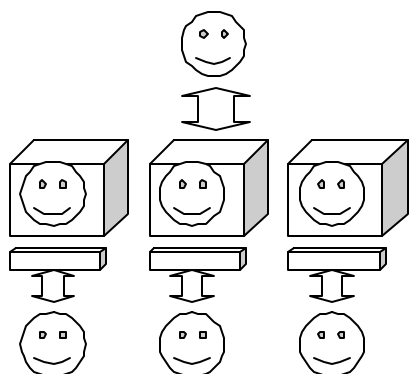


FIGURE. 3

APPROXIMATING THE ONE-TO-ONE STUDENT-TEACHER RELATIONSHIP IN A ONE-TO-MANY SETTING BY THE MEANS OF WEB-BASED TEACHING TOOLS.

WEB-BASED TEACHING

The world wide web is a wonderful teaching tool, and its applicability to teaching is only in its infancy, as many new and more effective techniques and methods for employing the web for the purposes of teaching are yet to be discovered. The key advantages of the web is its high availability, i.e. 24 hours a day, 7 days a week - and communal spirit, as everyone using the web can take an active part in a collaborative environment.

The most obvious use for the web is distribution of lecture notes. Although student surveys indicate that students prefer to read course material off-line on paper, this is not always feasible. Often, course notes for new courses are prepared during the progress of the course. Contents, such as lecture notes, can be continuously added and refined as mistakes are uncovered and additional points need clarification – all of this with virtually no effort associated with distribution. Secondly, the hypertext capability of the web allows additional resources and non-textual content to be linked and integrated with the textual content. Examples of additional content are: sample programs for programming courses, animations and externally provided information and resources. Further, important announcements such as cancelled lectures, exercises and assignments are easily distributed and broadcasted via the web.

This is particularly useful for students unable to attend all the lectures³ as they will not miss vital information.

Discussion groups are popular supplements to online teaching contents, where students can share between themselves information regarding a course. When used efficiently, and when a discussion group culture is established, such facilities can greatly enhance learning.

Assignments can be submitted electronically. Email is a popular means of managing assignments. Students compose an email message with the project as attachment and send this to the teacher. By using a specific subject title email filters can automatically move the incoming assignment-emails to folders dedicated to the assignment such that these messages do not interfere with other emails – and there can often be many messages in a short time-interval close to and immediately after a deadline. An important advantage of email submissions is that all messages are time-stamped. This eliminates nonsensical discussions and bargaining with students in cases of late submissions that incur penalties. Further, the submissions are authenticated as it is hard to forge the source email address. Drawbacks of electronic submissions are that it is more tedious and troublesome to add comments. A paper assignment is easier to evaluate and annotate. When it comes to administering submission lists emails are slightly better than paper lists. However, with many submissions it can be time-consuming to crosscheck email submissions against class lists, unless one has access to dedicated tools. We have experimented with web-based submission systems both at Oslo University college and National Cheng Kung University. An assignment is associated with a web submission form where the students identify themselves and provide a URL pointing to a location on the web where their submissions can be accessed. These web forms can employ a backbone database, and greatly simplify the administration task. The educator can then easily make queries such as:

- List late submissions
- List early submissions
- List students with no submissions.

The mechanisms for building such systems are addressed in the next section.

BUILDING INTERACTIVE TEACHING PORTALS WITH PHP AND MySQL

PHP (PHP: Hypertext Preprocessor) is a HTML (HyperText Markup Language) embedded scripting language with a syntax borrowed from C, Java and Perl. PHP scripts are placed into the HTML files and are executed on the server side before the resulting preprocessed HTML file is sent via the network to the client. PHP is used to design dynamic

³ Some students have children, and they occasionally miss lectures as they have to pick of children from kindergarten or stay at home when children are ill.

web pages using the capabilities to process web-form inputs and access databases. There are a number of other languages for creating dynamic web pages, but PHP has recently gained popularity. PHP is *open source* and widely available and therefore suitable for teaching institutions as there are no expenses associated with software licenses.

MySQL is an open source relational database system that is frequently used in conjunction with PHP. Its liberal licensing policy has increased its popularity and makes it very attractive to teaching institutions.

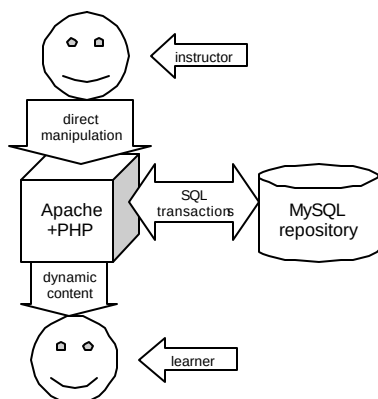


FIGURE. 4

PHP IS USED ON THE SERVER SIDE TO GENERATE DYNAMIC WEB PAGES USING THE USER INTERACTION AND AN SQL RELATIONAL DATABASE.

WEB-BASED PROGRESS TRACKING

One reason for the high exam failure rate is that some groups have “sleeping partners” that do not contribute and consequently do not assimilate the syllabus. This is analogous to copying. It is not feasible for the course instructor to manually identify these individuals when responsible for courses of several hundred students. Instead, the web server collects statistics regarding the student access patterns on the course website, abnormalities can be easily uncovered and actions can be taken to further assist the affected students. This is similar to the mapping of internet access habits by companies exploiting such information for marketing purposes.

For example, given an assignment presented on the web together with all the relevant lecture notes and additional background material. If students submit a solution but have not even accessed the assignment document or the other document, then something is obviously abnormal. A likely cause is that the affected students have copied the work from someone else or they simply take a “free ride”.

Access logs are also used to obtain information regarding how frequent different documents are accessed, at what times and for how long. Such statistics can be useful to show students who perform unsatisfactorily in the exams.

COLLECTING DOCUMENT ACCESS STATISTICS

Most web servers come with basic access monitoring logs and statistics. Usually, this involves storing each request for a web page, by storing the IP (Internet Protocol) address, access timestamp and the page requested for each request. These statistics are mainly used to rate pages on popularity and establish geographic access patterns. The statistics collected is limited and restrictive. One problem is that students use different machines in the teaching laboratories and at home. With today’s technology one cannot associate one IP address with one student.

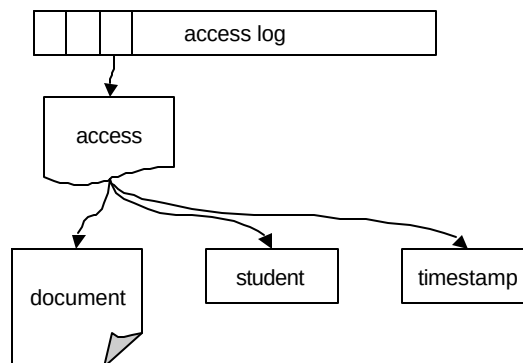


FIGURE. 5

ALL ACCESSES ARE LOGGED. EACH ACCESS IS ASSOCIATED WITH A SPECIFIC STUDENT, DOCUMENT AND TIME.

Cookies can be used to overcome this. A cookie is a small token stored in the client web browser containing a unique record recognised by the web site. However, cookies are easily deleted, their facilities disabled and logging in on machines on different network, such as home, does not conserve the cookie.

Our solution is to adopt a web site, or portal, where the students log in by providing a username and a password. This has two advantages. The course material is restricted to the participants of the course. Further, as students log in it is possible to associate and store requests together with the actual user, rather than an IP address or a cookie.

THE TEACHING PORTAL – LEARNER’S VIEW

As students access the web site they are confronted with a login form, requesting a username and a password. Students can also obtain their password if this is forgotten or lost. There are several options for how passwords are assigned, and this is a non-trivial problem. Currently, web users have to maintain many different passwords accessing different password protected portals such as web-based email etc. For purposes of simplicity we have used the campus login name as username and a specially generated password that students are sent via email⁴. Once the

⁴ Security is not critical in the teaching portal.

students have logged in, the portal appears like any teaching portal. Typical content includes:

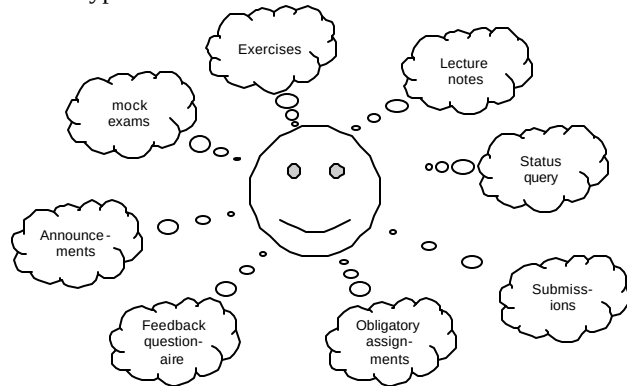


FIGURE 6

TYPICAL SERVICES AND CONTENT AVAILABLE TO STUDENTS ON THE TEACHING PORTAL.

- Message board with announcements from the lecturer.
- Lecture notes.
- Laboratory notes.
- Weekly exercises and solution.
- Obligatory assignments and solutions.
- Obligatory assignment submission form.
- Obligatory assignment pass lists.
- Past exam papers and solutions.
- Course evaluation and feedback form.
- Miscellaneous: literature lists, timetables etc.

Obviously, content is specific to the courses. However, the above list serves as a generally applicable content template.

THE TEACHING PORTAL – INSTRUCTOR’S VIEW

The instructor can access the portal in two ways: via the web interface and directly by accessing files on the web server. It is envisaged that the interface will be completely web-based eventually. For web based access the teacher has his or her own unique password, where the purpose is to avoid malicious parties hampering with the system and also to protect the assimilated statistics. The tasks carried out by the teacher include:

- Reading, adding, modifying and removing contents from the portal.
- Accessing statistics.

The only information added through the web interface is announcements placed on the notice board. Messages are entered using a designated form. Messages are stored in the database and formatted in a consistent manner when retrieved by the students.

Other material is currently manipulated directly on the web server using a file-manager. Unfortunately, the course

instructor needs to be relatively computer literate. Certain documents can be non-trivial to add, modify and delete. For example, lecture notes may contain diagrams, audio or even video. A HTML document does not embed such entities and each element must be added separately. Also, it is not trivial to modify a document by using a web interface.

When adding a new document the instructor must add a fixed pre-made snippet of PHP code to the head of the html code. This snippet ensures that all accesses of the document are logged in the database together with all the necessary attributes. Optimally, this mechanism should be transparent to the instructor.

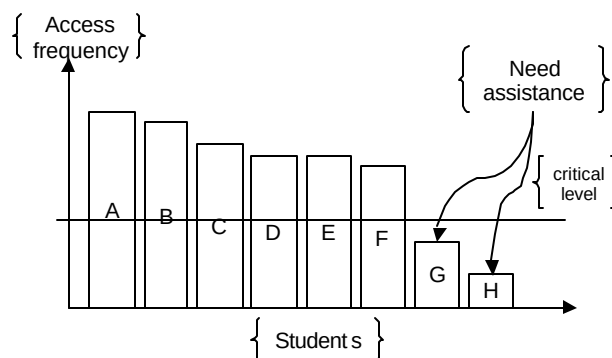


FIGURE 7

USING THE ACCESS STATISTICS TO IDENTIFY STUDENTS IN NEED OF GUIDANCE AND ASSISTANCE AND STUDENTS CAPABLE OF WORKING INDEPENDENTLY.

When evaluating students the teacher may wish to access the following types of queries regarding the usage patterns of the students.

- How many students have accessed a particular document and how often, and for how long they have looked at the document.
- Which students have accessed a document, and who have not.
- Which documents have particular students accessed, how many times and at what times.

Inspecting the access pattern of a certain document enables the educator to partially determine the usefulness and impact of a document. Such statistics can be the basis for making modifications to the lecture material or planning lectures. For example, if students only looked at a document for a couple of seconds it may indicate that the information is either too complicated or not interesting. It is impossible to accurately measure how long someone has browsed a document. However, it is possible to estimate this by taking the time-difference of two successive access log entries, when this duration is below a certain threshold. Further, it is useful to generate a list of students that have not accessed certain documents. For example, if reading a particular document is the prerequisite for a given activity, then such a

query can help to identify students that need assistance. Then, getting an access profile for a particular student can give useful insight regarding the particular set of students. The educator then has a smaller number of students to focus on and can judge these manually on a case-by-case basis.

Also, more complex and interesting queries can be made such as:

- Which students have accessed one group of documents A but not another group of documents B.
- Which students have accessed the documents such that the access times deviate significantly from the mean.

Imagine that a set of students have submitted an obligatory exercise and thus accessed the submission document. At the same time they have not accessed the assignment text or the supporting notes. How can they have managed to do the assignment without reading the assignment text? A simple query can identify students falling into this category, without tedious manual cross checking. Also, students with abnormal access patterns can be identified automatically and the access profile can be inspected manually by the teacher.

EXPERIENCES

The teaching portal described within has only been tried partially and not in its entirety. The ideas have evolved over time and features and facilities have been added during teaching. It is natural to evolve such a system as it is difficult to predict what will work. Therefore, a significant amount of experimentation with the various technologies and techniques are necessary in order to gain understanding regarding how these can best be applied.

Further, our intuition is that there are several similar initiatives underway at various institutions around the world. Educators are concurrently experimenting with similar ideas.

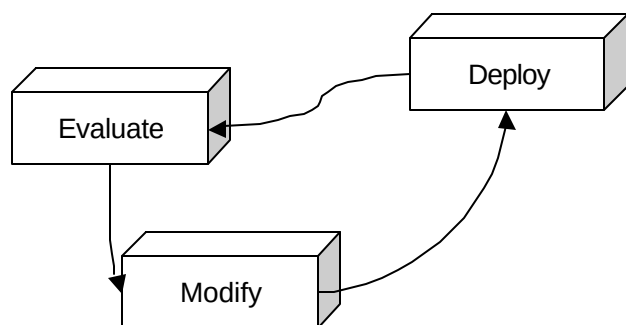


FIGURE 8

DEVELOPING A TEACHING PORTAL AS AN ITERATIVE PROCESS CONSISTING OF: EVALUATING THE CURRENT TEACHING STRATEGY, MODIFYING THE STRATEGY IN SMALL STEPS AND DEPLOYING THE STRATEGY.

SUMMARY

This paper addresses the evaluation and progress management of students studying engineering subjects, where there is a large student-to-teacher ratio. An approach is proposed where a web based tracking system is used to assist the instructor in identifying abnormalities in study patterns and thus identify students with difficulties. This enables the instructor to focus the attention on the most immediate problems and gives the instructor a better and continuous overview of the class situation when responsible for a large number of students. The study patterns are acquired from document access statistics where accesses are associated with both students and documents.

ACKNOWLEDGMENT

The first author would like to thank Hårek Haugerud at Oslo University College for inspiring discussions regarding web-technology in the context of teaching, and Sigmund Straumsnes at Oslo University College for hands-on advice regarding implementation issues.

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