TEST005.0 Introduction to the tutor-web

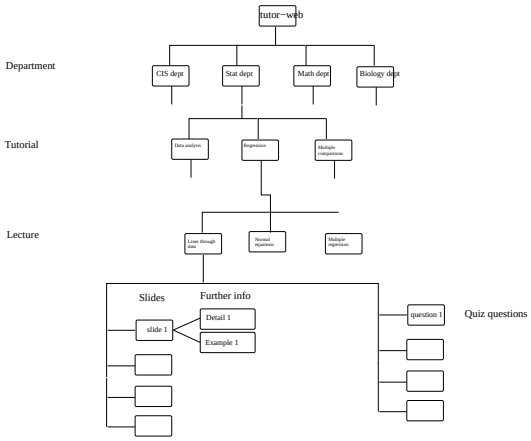
Anonymous

March 30, 2012

Contents

1 Overview

1.1 The tutor-web



- a freely accessible resource
- can store all educational material used in a classroom
- provides on-line evaluation.
- a database involving the structured storage of text and figures using predefined formats.
- Everything else is a "view" into this database.
- in Plone: has access control, improved instructor access

The tutor-web is a **freely accessible resource** which can store all educational material used in a classroom and provide on-line evaluation.

Think of the tutor-web as a database involving the structured storage of text and figures using predefined formats.

Everything else is a "view" into this database.

Since it's implementation in Plone, the tutor-web now has access control, so instructors have full control over their own tutorials.

The important design aspects are to take into account all material which an instructor needs.

For general usefulness it is important to have material and to get the views needed to inspect, utilise and modify material - but all the views are secondary since they can always be changed. Although this is considerable work it is trivial compared to entering the data.

The possibilities involved with the system (new views etc) are completely dependent on the initial definition of the database being sensible.

1.2 Slide content and structure

The slide is the center and can contain text and figures. The slide links to various other pieces of information.
The tricks:

- All content is interlinked: examples, detail, handouts, ...
- All "source" is accessible (R commands, LaTeX code etc)
- Predefined formats only (but many)

  This **text part** of this slide is in *structured text*, a format commonly used by programmers. For see the "Alternative" link of the web-page.

When the instructor/author has time on his/her hands, the slides can be augmented with addiitonal detail

such as the proof of a theorem etc. In this case the detail portion of the slide is used.

Note that the detail portion of the slide is accessible as a button on the web pages but is normally also a part of the printout.

Some programs which handle electronic slides call this part the “handout”. That is somewhat of a misnomer since these are really just additional notes to go with the slide and is normally limited to about half a page.

This particular detail section is simply written in “plain text” since there are no equations, bold symbols or bullet points.

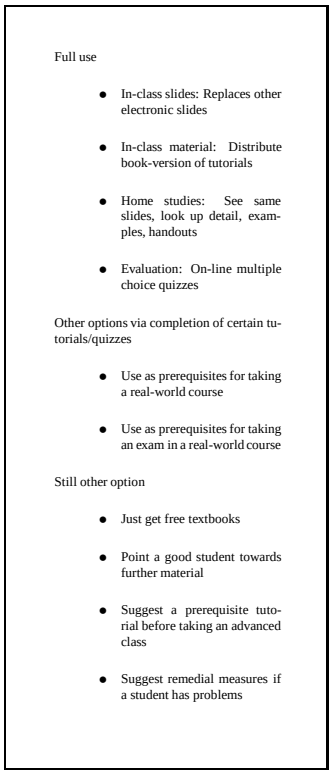
Example: Each slide can have an associated example portion where the author would insert examples relevant to the topic in the slide. Sometimes the example should also be shown in the slide presentation in which case it is placed in the explanatory portion which does not show up on paper.

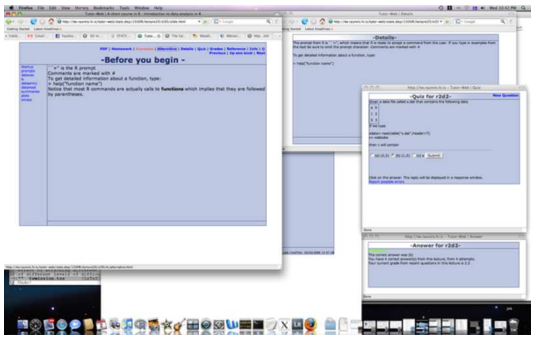
This example is written in LaTeX and allows arbitrary formulas such as

$$\int_{-\infty}^{+\infty} \frac{1}{\sqrt{2\pi}} e^{-\frac{-x^2}{2}} dx = 1.$$

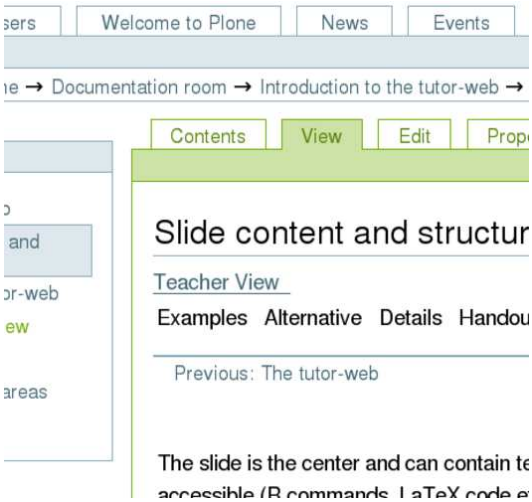
For the really diligent author the tutor-web has the option of a handout section for each slide. The handouts are pretty much freestyle and can span several pages. They are good for inserting long-winded explanations of a proof, quoting a long legal text and so forth.

1.3 Using the tutor-web





A student will flip to a lecture, possibly looking at the slides, and then proceed to take the quizzes.
Note that the student sees the same slides at home as in class - and has full access to all class-based material.



In the Plone version: Click on the teacher view button.
An authorized instructor can then see and edit all components of the slide.
A student can use this view to see all the components.

1.4 A student's view

1.5 The instructor's view

1.6 Partnerships

20+ instructors from 18 countries

1.7 Low-income areas

Many (most?) current partners are in low-income areas
Obvious benefits from free material
Access to special tutorials for good students
Access to tutorials for remedial math

1.8 Conclusions

2 The content

3 A project proposal

3.1 Executive summary

The “tutor-web” is a system for computer-assisted education and research on education, both for in-class use and for remote learning. The system is free and includes the possibility of a student taking exams. Instructors anywhere can set up, exchange and use teaching material.

Development will include complete material for courses in fishery science; for an undegraduate degree (BSc) in mathematics; and for a graduate degree (MSc) in applied statistics.

Although the system will not confer formal degrees, universities around the world can use degrees or grades from the system for their own purpose, whether as prerequisites for entrance or as course equivalents.

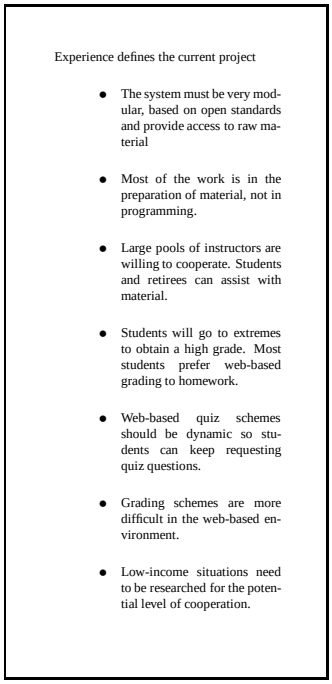
Future hardware upgrades and research will be funded by grants but the system will mostly be self-sustainable like other open systems such as WikiPedia\footnote{http://www.wikipedia.org}. An important difference between the “tutor-web” and Wikipedia is that since the “tutor-web” is designed in part for in-class use, content is “moderated”, i.e. only “instructors” are permitted to insert material. Further, although the basic concept of an on-line university already exists in several forms, none of these encompass the simple requirements of being freely available, providing complete access to all material and providing evaluation (see section \ref{sec:unique}). One reason for the reluctance to do this may be simple conflicts of interest as the parent universities may not realise how the potential benefits of access to the “tutor-web” outweigh any potantially negative aspects.

The following short list identifies the essentials of this proposal:

\fbox{\parbox{15cm}{ {\bf Primary goal:} Build an active web-based university.\\ {\bf Impact claim:} This has the same potential impact as Wikipedia: Provides a basis for exchanging teaching material; provides a basis for students to take on-line graded exams; underprivileged students and universities gain free material, evaluation schemes and cooperation.\\ {\bf Other goals:} Evaluation of methods for on-line testing; Obtain a critical mass of students using the system; Obtain a critical mass of participating university lecturers using the system.\\ {\bf Staff:} Support staff, computer programmers, PhD students, postdocs, faculty.\\ {\bf Deliverables:} Tutorial sequences for two university degrees.\\ {\bf Milestones:} Registration procedure available for a degree including complete course listing; Student registration reaches 1000; Teacher participation reaches 100 active teachers.\\ {\bf Publications:} Monographs on design; papers on case studies on low-income countries; papers on how learning is affected by different quiz designs; } }

In simple “open source” scenarios such as when individuals are free to write software to their own liking, there is little need for outside grants, but some form of funding is generally needed. The project presented here is a combination of research on computer-assisted education, development of a freely accessible cyber-university and R\&D on the use of this system in low-income countries. Funds raised will be used for {\bf research} on how the “tutor-web” can best be implemented in several settings, including low-income countries and as a {\bf catalyst} to entice partners to participate in providing content, e.g. by funding graduate students of individual faculty.

3.2 Historical notes



The "tutor-web" has been developed by several teachers, students and programmers based on experience gained by instructors while teaching university courses or giving presentations at several universities while funded by several funding agencies[1]. Presentation experience taken into account when designing the "tutor-web" includes regular classroom teaching through public presentations to highly variable audiences. The corresponding material includes a variety of topics (mathematics, fishery science, applied and theoretical statistics, computer science and even business proposals).

The "tutor-web" has also been used as a vehicle for research on educational methods and can be used to develop presentation schemes, evaluate grading schemes, quiz generation methods and so forth.

Some fundamental conclusions have emerged as a result of this work and these are used to define the current project:

- A system intended to store all teaching-related information must be very modular and based on open standards. An open-content web system needs to provide access to raw material, not just presentation-level material.
- Most of the work involved in setting up a working system is in the preparation of material, not in programming.
- Large pools of instructors are willing to cooperate on teaching material but do not have the facilities to do so. Teachers require a user-friendly interface (but students generally do not). Students and retirees can assist with much of the material, given the right environment.
- Given the means, students will go to considerable extremes to obtain a high grade. Most students prefer web-based grading to homework.
- Web-based quiz schemes should be dynamic so students can keep requesting quiz questions until they have learnt the material.
- Grading schemes are more difficult in the web-based environment. More thought is needed than randomly handing out quiz questions.

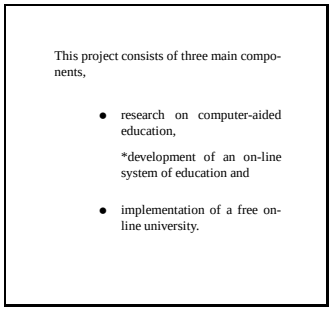
[1] See acknowledgement section

- Low-income situations need to be researched for the potential level of cooperation. Some can clearly become providers, some can utilize material but special solutions may be needed in some cases.

These claims are described in detail (and justified where needed) in this proposal and form the basis for the research and development proposed here.

An important conclusion from the above is that (1) further research is needed to evaluate fundaments of the on-line quiz concept and potential for low-income education, (2) cooperation on a large scale is needed for content development and (3) by adding content, the "tutor-web" can become a free on-line university

3.3 Introduction



This project consists of three main components, research on computer-aided education, development of an on-line system of education and implementation of a free on-line university. A considerable portion of this work relates to low-income education, including building bridges for cooperation, case studies in low-income areas, research on which methods can be used in which environments and so forth.

This proposal contains R&D-work on general methods for dissemination of teaching material, including self-evaluation, information storage methods and computer-based presentation to students at any level. The resulting open-source and open-content "tutor-web" has also been used for research into educational methodology.

This documents contains the project proposal itself along with background descriptions of the "tutor-web", which is to be used as a development platform.

The possible impact of the methodology is tremendous since the content is stored under open-access licenses and this has the potential of giving low-income countries access to first-class material and enhancing cooperation of instructors across continents. The current (pilot) "tutor-web", already contains considerable material in several fields of study, e.g. a 15 ECTS[2] course on fish population dynamics used in the United Nations University Fisheries Training Programme (UNU-FTP).

The impact of the "tutor-web" in a single course in a western classroom can be considerable. This will be dwarfed by the international impact of having open computer-aided instruction available for the high-quality course-based MSc degree in applied statistics and the BSc degree in mathematics to be designed in this proposal. Taking this up one level, the potential effect of the "tutor-web" on collaboration, entrance tests and education in low-income countries can be much greater than that again.

Section **??** provides a short synopsis of the proposal. Section **??** describes the current state of affairs along with general principles which need to be followed for developing a general-purpose educational web for storing and presenting all material as wel as being used for testing and grading students. This section describes some of the differences between the "tutor-web" and other approaches.

Section **??** describes the current "tutor-web" design itself whereas **??** gives some of the next steps in its

[2]European Credit Transfer System

development.

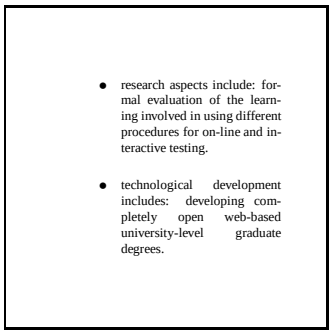
Web content will be developed in this project, including developing complete material for two university degrees. This will be implemented through a strategy which combines research, studies and generating material as described in section **??**.

In order to specify what kind of research is important, some principles of web-assisted education need to be laid out, as is done in **??** whereas the proposed research is described in section **??**.

Section **??** describes the approach which will be taken first in terms of research and subsequently implementation of the "tutor-web" in low-income situations. Finally, **??** describes the other extreme, i.e. near-term development of the "tutor-web" for the high-tech situations, such as high-resolution screens and mobile phones.

Annexes give detail on issues such as cost estimates, the background of the principal investigator, the research environment and so forth.

3.4 Project synopsis: Computer-assisted learning



\label{sec:synopsis} The research aspects of this proposal include formal evaluation of the learning involved in using different procedures for on-line and interactive testing. The technological development includes developing completely open web-based university-level graduate degrees. The work will be based on the pilot "tutor-web" \citep{stefansson2004twe}, a web-system of education for in-class use, remote learning and research on web-assisted education. The system (in its pilot version) allows any teacher to use any material in class, and any student to freely read the material or take quizzes to obtain grades. This system will be further enhanced within the present project to include complete programmes in the form of a course-based BSc degree in mathematics and an MSc degree in applied statistics. This will be done through the use of faculty and graduate students in various countries around the globe as well as all postdocs and PhD students in this proposal. The first result will be on-line course material in graduate-level statistics available to universities world-wide, permitting e.g. an understaffed sociology department to direct students to take an on-line tutorial on contingency tables \— free of charge.

The "tutor-web" has already been used for evaluating simple research questions such as whether there is any gain from using such a system in conjunction with a classroom (the answer being very positive). It has been found that students tend to take on-line quizzes enthusiastically and tend to try to continue until the maximum grade is obtained, if this is permitted. Other research questions abound, however, the most obvious being how to select questions to give to students and how to evaluate their grade in a dynamic environment where it appears to be optimal to permit students to repeat requests for questions ad infinitum. Earlier analyses of "tutor-web" data have been based on contingency tables along with (generalized) linear models but future analyses will be based on specially designed experiments where mixed effects models will play an obvious role.

In a social research context, the present proposal will generate a more general test-bed for evaluating how on-line quiz material can be utilized. The first such test, within the project, will be a non-statistical (qualitative) social study on how low-income participants respond to a requirement of the form "You do not have the requirements for entry into this program, but you will be considered for entry when you

complete course X on the tutor-web with a grade of Y". The same approach will be tested on active graduate students who lack background in maths or stats as well as on UNU FTP students.

The proposal contains a strategy to recruit academic professionals and students from Europe (in particular Iceland and Romania) and beyond (including South America, Asia and Africa) to use and add to the "tutor-web".

Since the "tutor-web" is based on a formal database description, it is possible to view content in various ways. A particular future option will be a view into the system for portable devices such as palmtop computers or capable mobile phones. This will enable the option of downloading or interactively answering quiz questions while commuting on a train. Such options (along with streaming audio or video at the high end) clearly show the educational potential of this project. The project will also lead to considerable future research, in particular on presentation methods and testing schemes. Since the "tutor-web" is free for the student it is a minor requirement that students should agree to participate in such experiments, which can provide massive data on student responses to different strategies.

3.5 Computer-assisted in-class learning

\label{sec:cae}

{\bf State of the art} Currently most of the world's teaching probably uses a blackboard and chalk whereas the western world is moving towards whiteboards and pens along with (electronic) slide presentations in many cases. Handouts on paper are commonly used with textbooks. Homework, quizzes and exams are used to monitor progress.

Elaborate uses of electronic media abound but most uses consist of the lecturer making electronic slides available in electronic or paper format (see references in \cite{stefansson2004twe}). This applies to the actual use of most commercial and open-source systems available today. Such uses are not of much interest since they merely give the student access to copies of slides presented during class. Similarly, storing handouts on-line are rather petty uses of the web's potential. In either case nothing is gained over and above simply distributing paper versions in the classroom. To use the possibilities of the web a system should interlink the material and add options for testing.

The same comments apply to most on-line testing schemes. In many cases these are merely repetitions of paper schemes, i.e. a student is handed a fixed set of questions and required to solve the test in a given amount of time. Although this may save instructor-time, this gives no credit to the immense possibilities in the interactive nature of the web.

Many theories and models are available of how students learn and many approaches have been suggested on how to change a student's learning experience or simply to drastically change approaches to teaching (with a given purpose in mind). Thus, \cite{moore2005her} discusses "transformative learning", but \cite{felder1988lat} take a more formal approach to defining key dimensions of learning and teaching, indicating how a teacher can get the attention of all students by catering to how each "type" of student learns. In many cases distinctions are made between traditional schools and adult education \citep{mezirow1981cta} but this distinction is blurred in the case of undergraduate and graduate studies.

It will be seen in the following that the principles underlying the "tutor-web" provide all the functionality needed in a classroom, e.g. interlinked electronic slides and handouts, with corresponding quiz questions.

{\bf Licensing and formats}

The Internet has adopted certain standards for distributing content. These are all according to open definitions which anyone can access. For this reason anyone can freely obtain programs which can read and write such content. This is important for two reasons: A classroom may not be able to afford the most up-to-date version of a word processor and a proprietary format will eventually become obsolete leading to loss of text. Unfortunately web-based systems for education have generally ignored these

rules of the Internet and proprietary internal solutions abound.

Similarly, any closed licensing rules to software imply that an instructor wanting to enter information can not do so without purchasing up-to-date software and this is unacceptable if global participation is wanted.

{\bf Features of systems} \label{sec:features}

Different systems for computer-aided instruction have different features. The following compares a few of these features and illustrates how some alternative systems compare with the "tutor-web"\footnote{See http://tw.raunvis.hi.is:8080/tutor-web-info/docs for further information}. Later sections describe the "tutor-web" in more detail.

Content providers include connexions\footnote{http://www.connexions.org/} which allows the storage of educational content such as the tutorials on the "tutor-web". It does not, however, include quizzes, slides, portability between systems or open standards for content (which are neede for complete portability from the teacher's application to the end product, printed or web page).

In particular, connexions does not automatically support LaTeX which is essential to obtain a large base of math instructors.

Connexions and the "tutor-web" do, however, share the idea of using small parts of lectures as a knowledge unit. In connexions these are called "modules" whereas on the "tutor-web" these are the "tutorial". A course in the real world will typically consist of several weeks of lectures, e.g. 12 weeks of lectures with 4 lectures per weeks or 30-50 lectures per course.

Attempting to set up an on-line version of a complete course is therefore quite prohibitive for an individual instructor in any given year. A tutorial on the other hand typically consists of only a few lectures, e.g. 4-10 lectures, i.e. 1-3 weeks of lectures. Setting up a computer version of such a small subset of a course is a much more feasible undertaking. The tutorial can therefore also be on a more isolated topic, which can also be more easily reused in several different courses.

A totally different approach is taken with the Educommons Open CourseWare (OCW)\footnote{http://cosl.usu.edu/projects/ed approach used by many universities, including the Massachusetts Institute of Technology (MIT)\footnote{http://ocw.mit.edu/C Utah State University (USU)\footnote{http://ocw.usu.edu/Index/ECIndex_view}, Johns Hopkins Bloomberg School of Public Health\footnote{http://ocw.jhsph.edu/} and others. The difference between this and the "tutor-web" is best put on the MIT web-page, when referring to the the OCW at MIT ... "It is a snapshot in time of how a particular subject was taught by a particular member of the faculty in a particular semester...". Notably these tend to be PDF files containing lecture slides and notes, not suitable for editing by others and thus permanently static. This is useful material, but not the kind of material best suited for collaboration and exchange of teaching material with the intent of also enhancing it.

Finally, one should note that content providers do not try to offer evaluation of students, i.e. there is no grading mechanism nor are credits given in any form. The current "tutor-web" has a grading system for tutorials and this will be developed into a complete grading and credit system for courses as a part of the research proposed here.

Encyclopedias on the web include Wikipedia which is exactly that: A free and publicly available encyclopedia on the web.

Alternate systems include Moodle\footnote{http://moodle.org/} which is not as tightly integrated as the "tutor-web" and relies on a fairly different philosophy regarding content, presentation and interactions between instructor and students and Wikiversity\footnote{http://en.wikibooks.org/wiki/Wikiversity}, a Wikipedia university which only stores content. A comparison\footnote{http://tw.raunvis.hi.is:8080/tutor-web-info/docs/docs/comparison.html} is available with a summary below.

These alternative sources of information are opportunities rather than competitions and the "tutor-web" should include links to such information sources. The "tutor-web" has facilities for such links and instructors designing a tutorial are encouraged to include links to such material, whether alternate tutorials

such as Connexions or OCW, or encyclopedic entries. Notably, these links are set up in such a way as to pop up in an isolated box so as not to lead the student too far astray from the main theme of the tutorial. Methods should preferably be developed to extract information from tutorials from the tutor-web into connexions or other similar facilities, based on appropriate agreements. If detailed lectures on the "tutor-web" are used as content for connexions pages, with back-reference, this providing implicit advertising for the "tutor-web". Several format-conversion issues need to be resolved before this kind of exchange can become a reality.

Several on-line private and closed-source/content initiatives also exist. These are not really competitors with the "tutor-web", but notice should be taken of some of the approaches used. Most of these systems require extensive instructor-student interaction (more than in a regular classroom) and this is not acceptable in most scenarios. However, a few systems have been developed paying great attention to detail and learning theory. Most of these systems appear to be highly specialized and only applicable for the narrow topics for which they were designed.

As described in detail in the following section, the "tutor-web" design has the unique\footnote{On uniqueness, see \cite{stefansson2004twe} and http://www.hi.is/$\sim$gunnar/grants/tw for links and comparisons with other systems.} approach of interlinking all educational material to be used in a classroom with the purpose of easing the burden of the instructor and enforcing learning insomuch as this is possible. Since the "tutor-web" is open and lecturers store raw material on the web (rather than PDF files), this permits other lecturers to either participate in modifying content or to copy lectures and use them in new ways. The web pages are open to any student and instructor who can openly access the system for viewing and taking exams. These factors work towards enhancing teacher cooperation, making material available to universities with less resources and making education available to more students than before.

The quiz aspect of the "tutor-web" forms an entire area of research and development. It has already been demonstrated that students tend to prefer the on-line quiz over homework. Further, the use of the on-line quiz has a positive impact on knowledge, as demonstrated by the statistically significant ongoing improvements while using the web\citep{sigurdardottir2006}. Finally, results from the web-based quizzes are positively correlated with results from a final exam\citep{stefansson2004twe}.

Comparisons between the various approaches to storing and presenting educational content are virtually impossible since these approaches are based on completely different design principles, as seen in section \ref{sec:features}. Notably, however, most systems are used mainly for storage of educational material and at most enable an instructor to download slides (or other material) for presentation in-class (EduCommons, Wikiversity, Connexions). In spite of these obvious problems, the "tutor-web" has been compared with other systems both in publications \citep{stefansson2004twe} and on websites\footnote{http://www.tutor-web.info}.

{\bf Uniqueness}

\label{sec:unique}

The "tutor-web" is intended for handling and storing everything an instructor might use in class, and allowing a student to do the same from other locations, as well as for student evaluation \— and doing this in a linked manner using only non-proprietary solutions.

The uniqueness of the "tutor-web" comes from having {\bf all} of the following features: \begin{itemize} \item Storage of all educational content: \begin{itemize} \item Slides \item Examples \item Additional details \item Handouts \item Quizzes \end{itemize} \item Stored material is {\bf linked} and can be viewed in different ways \begin{itemize} \item As web-slides or PDF-slides \item As booklets containing slides interspersed with other material \item Other views can be generated \end{itemize} \item Code is "Open source" \item Material is "Open content" \item Source material is available in raw form, e.g. \begin{itemize} \item Not just as PDF \item Data behind an image can be viewed by the student \item Text or graphs can be borrowed for inclusion in another lecture \end{itemize} \item Students can take quizzes on-line \item Students can take quizzes repeatedly until results are satisfactory \item Content is stored in a modular manner (object-orientated data base) \item Content can be viewed in different ways

(will be user-defined) \item All views are easily modified \end{itemize}

These features are described partially in section \ref{sec:twdesign} but more detail is given in \citep{stefansson2004twe}.

3.6 The design of the "tutor-web"

\label{sec:twdesign}

{\bf Structure: Layout and modularity}

The "tutor-web" can only be superficially described here, but the material is aggregated around slides, which are grouped with quiz questions into lectures, which again group into tutorials corresponding to a topic (Fig. \ref{fig:twcontent}). A typical tutorial may correspond to 5-15 real-world lectures and hence a real-world course may e.g. correspond to 5-10 tutorials. This approach makes the tutorials potentially useable in several courses and easier to set up initially. Naturally, an intial tutorial may contain only slides or only handouts etc, eventually building up over time to include all items used for a class, complete with quiz material.

\begin{figure}[htbp]\begin{minipage}{1.0\textwidth}\begin{center} %\rotatebox{-90}{\resizebox{5cm}{!}{\includegraph
\rotatebox{0}{\resizebox{13cm}{!}{\includegraphics{twlayout.eps}}}\caption{Tutor-web structure of content.} \label{fig:twcontent} \end{center} \end{minipage} \end{figure}

The most important aspects of the "tutor-web" are the overall layout and modularity as all possibilities follow from this layout. The tutorial-lecture-slide setup is one aspect of this structure, where the concept of a slide forms a certain theme.

Another aspect is how content is laid out around each slide. A slide can have certain pre-specified features (title, main graphic and so forth). In addition, a slide may contain links to additional material, e.g. more detail on a topic, examples, handouts or homework.

Every such item handled separately and can be of a pre-specified type (whether postscript, latex, R commands etc) and this forms the essence of the modularity. Additional types are easy to add, as long as these adhere to the concept of open standards.

%\begin{figure}[htbp]%\begin{minipage}{1.0\textwidth}%\begin{center} %%\rotatebox{-90}{\resizebox{5cm}{!}{\inclu
%\rotatebox{0}{\resizebox{13cm}{!}{\includegraphics{ttt.ps}}}%\caption{A screen dump of a high-resolution "tutor-web" screen, % illustrating a slide, the quiz and response window etc.} %\label{fig:twscreen}
%\end{center} %\end{minipage} %\end{figure}

{\bf Linking information}

The structure implies certain implicit links, the obvious being that slides belong within lectures and quiz questions also belong within lectures.

Alternative structures and links might of course be envisaged but the present version is a result from a multi-year pilot study.

{\bf Views}

The structured and linked nature of this web implies that slides in a lecture can be printed, 6 slides to a page (a standard feature); or a booklet can be printed containing all material with one section per slide, examples and detail per slide as base material but the slides as pictures (also a standard feature).

As is well-known, web-pages tend not to be of the same quality as e.g. PDF slides. Hence one "view" of the system is to obtain slides in PDF format.

Alternative views can easily be generated should this be useful. For example, section \ref{sec:userview} describes how a user might specify a desired design\footnote{This is done e.g. on Facebook, http://www.facebook.org}.

{\bf Navigation: An example from fishery science}

A user enters the pilot version of the “tutor-web” by clicking on\\ \fbox{http://www.tutor-web.net}\\ and is presented with the view at the top-left in Fig. \ref{fig:stepwise}. To give an example of how a user might navigate the system, consider an instructor or student wanting to consider the UNU-FTP “Fish population dynamics and assessments” course. This course consists of several tutorials in the “Fishery science department” of the “tutor-web”.

To get there one clicks on the link “Fishery science department”, which leads to the page \\ \fbox{http://tw.raunvis.hi.is/tutor-web/fishsci.dep/}\\ as indicated in the second panel of Fig. \ref{fig:stepwise} and from there one goes to “Yield per recruit analysis”, which again leads to\\ \fbox{http://tw.raunvis.hi.is/tutor-web/fishsci.dep/1202yieldrec/index.html} and this page which gives an overview of the 5 lectures within the “Yield per recruit analysis” tutorial as seen in the top-center panel of Fig. \ref{fig:stepwise}.

In the top right-hand corner of this page (not shown) is a PDF-link, which downloads a PDF version of the entire tutorial. This includes all text and slides (as text boxes or figures), in this case a small 29 page booklet.

The first of these lectures is merely an introduction, but clicking on the second gives a detailed description of how yield-per-recruit computations are undertaken. Clicking on this goes into the web-version of the slides \footnote{http://tw.raunvis.hi.is/tutor-web/fishsci.dep/1202yieldrec/lecture20/sl00/slide.html} (alternatively one could have clicked on the PDF link to get prettied, PDF-style slides). Within the web-slides one can then follow links to go from one slide to the next, look at examples, background detail and so forth.

%\begin{figure}[htbp]%\begin{minipage}{1.0\textwidth}%\begin{center}%%\rotatebox{-90}{\resizebox{5cm}{!}{\inclu
%\rotatebox{0}{\resizebox{13cm}{!}{\includegraphics{stepwise.ps}}}%\caption{Navigating through fishery science on the tutor-web. A typical % navigation scenario is from left to right in the top row followed by % right to left in the bottom row.} %\label{fig:stepwise} %\end{center} %\end{minipage} %\end{figure}

Consider the particular slide describing the yield-pre recruit curve (click on the short-cut “yrcurve” on the left \footnote{http://tw.raunvis.hi.is/tutor-web/fishsci.dep/1202yieldrec/lecture20/sl90/slide.html}). This figure provides an example of how a student can be given complete access to all information underlying a plot. If one clicks on the figure itself, the figure alone is given in the browser window through the link \\ \fbox{http://tw.raunvis.hi.is/tutor-web/fishsci.dep/1202yieldrec/lecture20/sl90/base.png}.\\ Although this will be made more user-friendly in the future, the pilot version can already give the raw code behind this figure by merely modifying the trailer of the link from “.png” to “.r”\\ \fbox{http://tw.raunvis.hi.is/tutor-web/fishsci.dep/1202yieldrec/lecture20/sl90/base.r}\\ and students tend to find this particularly useful when studying how to do analyses, plots and so forth.

The extent to which all these options are implemented will of course be instructor-dependent and all features will only be used in few cases. When teaching by example, however, it is unquestionably very useful that the student has complete access to all data and code behind the examples which the instructor uses and presents on a screen.

It has been found that most students tend to want to look at these examples in some detail and some students will do this in class, i.e. browse the “tutor-web”, looking behind the slides as the lecturer presents the material.

3.7 Next-generation “tutor-web” design and development

\label{sec:next} {\bf Current development}

The current version of the “tutor-web” at http://www.tutor-web.net along with existing test cases should be considered a proof of concept from a pilot study. The following describes ongoing development to enhance the “tutor-web”. Section \ref{sec:expansions} describes further expansions into other languages,

accommodating a large user base and so forth.

Alpha versions of the new systems, using object-orientated data base systems rather than simple HTML and perl exist \footnote{see various links at http://www.hi.is/$\sim$gunnar/grants/tw.}.

{\bf Teacher interface}

A computer programmer will develop the "tutor-web", including an easy-to-use interface for instructors. This work is already underway.

Modifications include much better handling of mathematical symbols, easier previews, easier text entry, more format options and so forth.

{\bf User-selected designs} \label{sec:userview} Extensions will include user-selected designs, e.g. lecturers select in-class slide format, students select content-view layout (cf view slides, theory and examples side-by-side) and quiz questions may contain pointers to explanatory material and/or an explanations for incorrect responses.

Given the work required by the instructor for implementing such features, they will all be optional.

{\bf Evaluation of material}

It is important that errors in material be corrected (or at least noted) and there are several approaches to this. The simplest is by providing an e-mail address where students can report errors in questions and so forth. This is very useful since it can be quite hard to verify hundreds of questions but students inevitably find these errors\footnote{Such error message may have to be turned off or changed to web-reports in some cases if instructors get overwhelmed by reports which are due to difficult questions which are not errors.}.

Students should be allowed to grade their experience with material as in regular "student evaluations of teachers" (SET).

An important quality feature will be to also allow teacher evaluation of teachers (TET). This would be a useful feature in many systems but is quite important when there may be many instructors with material of variable quality. In this case the best approach is to allow instructors to evaluate ("grade") material.

The simpest grading scheme for content is automatic and merely reports the average grade students obtain on each quiz question. This approach is currently used to ensure that students end up also answering difficult questions.

There is nothing wrong with having multiple tutorials on similar topic. In the long run the SET and TET approaches will lead to competition and selection of tutorials to be included in courses or degree programmes.

{\bf Courses: Linking tutorials to reality} An instructor (or university department) should be able to define a concept of a "real" course which would naturally consist of a collection of tutorials. Such a course should correspond to the material which an instructor presents in a class during a semester. Passing all the tutorials in a course should ideally correspond to passing the real-world course.

At the same time, prerequisites for a course or tutorial should be defined \— simply as a collection of tutorials.

Each tutorial will have several associated attributes. An obvious attribute is a list of prerequisite tutorials, another is a definition of "internal tutor-web credits". Typical credit systems in the real world give 10-30 credits for a full-time semester with e.g. 4-5 courses. Here, a finer scale is needed since each course may consist of 10 tutorials. An internal credit will therefore be defined so that 10 "internal tutor-web credits" correspond to 1 credit in the European credit transfer system (ECTS), where there are typically 30 credits in one 15-week semester.

How "tutor-web" credits transfer into real-world credits will depend on the real-world university and

some research is warranted before any suggestions are made on this topic. There are, however several possibilities, linked to the possible uses which a university may put the “tutor-web”.

In-class uses of slides and corresponding uses of quizzes for a basic usage where the instructor is in control of material - and the students take an exam at the end of the semester. In this case the “tutor-web” merely augments the usual in-class sessions.

In the more general case students may have been directed to undertake independents studies or may have done so on their own accord. It is in these cases that the most interesting scenarios arise and they give rise to the greatest potential. A student directed to take a tutorial (sequence) in order to accommodate an instructor’s requirement is a simple example. In a sense this implies that the instructor has accepted the “tutor-web” content as a surrogate for taking certain courses \— and this is an easy way of merging the tutor-web into real-world requirements.

Similarly it is likely that an admissions body will look more positively on a candidate with a high “tutor-web” score than one without one, if both are competing for the last slot in a graduate programme.

Further on, however, more concrete methods will be needed to link “tutor-web” grades and credits to entrance requirements (or even degrees). Of these, the credit part is fairly easy: The “tutor-web” instructor will simply define an “internal tutor-web credit” for each new tutorial. The TET grading will include an evaluation of the consistency of these and other instructors or universities will be able to assign their own credits to a tutorial. This will of course not have any legal implications but will serve as an indication for the corrsponding instructors or admissions departments (who are free to use such credits or not).

The grading schemes are more difficult and require considerably more research, along with how questions are assigned, as seen elsewhere in this proposal (section \ref{sec:quizresearch}).

\subsection{The quiz formats} \label{sec:quizformat} The pilot “tutor-web” quiz formats basically consist of a question, a correct answer and 2-3 incorrect answers, with an option of a “none of the above” answer, which may of course be correct (NOTA+) or incorrect (NOTA-). Programmed questions (implemented in R) can of course randomly generate any text and e.g. randomly select between NOTA+, NOTA- or no NOTA.

All present implementation have permitted the student to select questions for an unlimited time. This approach forms one of a few fundamental principles in an attempt to utilise the interactive nature of the Internet. What remains, however, is the question of how grades should be computed since some students will tend to keep guessing for a very long time in an attempt to get a long enough run of positives.

Current HTML does not permit mathematical symbols in answer “buttons”, which implies that questions have to be set up so as to include all the mathematics in the body of the question. Naturally this could be improved upon, but ideally this should be done without compromising on standards, which may be difficult.

It would be a useful addition to routinely include optional pull-down menus for selecting among multiple items. This has been evaluated, but grading schemes have not been set up for this yet.

A much more important addition, however, is to allow instructor-defined probability-weighting schemes for the quiz questions. In the simplest case questions are generated at random, but this is clearly not enough to take into account the “guessers” who may know the answers to a fraction of the questions but guess the rest until they get a lucky run. If the selection of questions gets weighted towards more difficult questions as the grade increases, this will not occur.

A better, user-specific method would weight the probabilities towards questions which the user has earlier answered incorrectly.

A still better method (partially implemented) will occasionally select questions from earlier lectures in the tutorial, with a bias towards questions which the user has answered incorrectly earlier.

Better yet, quiz questions dished out from within a tutorial should also from time to time be selected

from an earlier, prerequisite tutorial. It is well-known that practice makes perfect and selecting (user-based and difficult) questions from earlier material will ensure that the quick user does not simply forget the material after having moved on.

Research on the use of these methods is described in section \ref{sec:quizresearch}.

4 testing more choices