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Full Paper

Decentralised Multimedia Development by the Content Experts

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Abstract

This paper describes the possibility to develop interactive educational material by the content expert (teacher). It is suggested to develop small modules of flexible material that can be easily changed similar to traditional lecture presentations. The features of such material include:

- *Learning by problem solving and application of knowledge (constructing knowledge).*
- *Easy internet on-line implementation of software pieces via Shockwave technology. At the same time CD-Rom versions of the same programs can be marketed.*
- *Integrated assessment by progress tracking and uploading via the web.*
- *Feel of ownership (avoiding the 'not invented here syndrome' of the program by the teacher.*
- *Possible exchangeability of small modules between different courses.*
- *Built in recording of student comments for improving and debugging program for the next year*
- *Facilitated input by students (over a year by year updating).*
- *Teachers develop expertise in using the modern and effective teaching tools.*
- *Teachers can put into practice much more effectively than before the educational principles learned from staff development sessions such as (self paced learning, problem based learning, deep learning, constructive learning).*
- *Student feedback (questionnaire) indicated that > 85% of students found the program modules were more effective and more 'fun' learning than traditional methods*

On-line Lecture Notes

An increasing number of teaching institutions recognise the need to provide more interesting, more active and more effective learning materials than the traditional classroom or lecture style approach. With the move towards using the internet as an information carrier, tertiary institutions world wide offer courses and subjects on-line. Because of a limited budget for the development of new teaching technologies many universities seem to simply revamp their traditional lecture notes, study guides, laboratory manuals, etc. and make them available on the web. While this approach entitles universities to claim they offer units 'on-line', not much is improved from the student's point of view. Often the only interactivity offered on such sites is clicking on links to other pages. Viewing text and images on the computer is still less effective than viewing properly printed material, such that students are tempted to print out the 'on-line' material and learn in the usual way. There is a certain likelihood that students that compare the web offerings of a number of tertiary institutions may wish to enrol in those institutions that offer the more interesting, more optically appealing or more interactive websites.

The addition of links to other websites clearly improves the web based teaching as long as the other sites offer good quality material and are persistent. While this open ended constructivism approach of learning (here is the world of information, please learn) may result in very fruitful learning for some students it seems far from guaranteeing an acceptable learning outcome for the bulk of the class in particular if there are tangible learning outcomes that must be met in courses such as science and engineering.

Professional Multimedia Projects

The development of material that takes full advantage of computer assisted learning or online learning is much more involved and typically employs interactive learning and multimedia techniques. Typically such material is developed by a team (content expert, instructional designer, graphics designer, programmer, user representative (student), manager). A typical multimedia team will require substantial amounts of time and funds (e.g. $ 50,000) for the development of a small fraction of one typical university unit (subject). Often, in spite of the use of graphic designers, the presentation of the final end product can not match that of commercial products that student are exposed to when engaging in computer entertainment activities. The resources for the development of such projects are usually only available for a small number of prestigious units (the flagships) or via federal funding projects. Some of the drawbacks of this approach to generate tertiary teaching material are:

- High costs.
- Program difficult to update or improve by content expert. Typically the content expert (teacher) would want to amend or update the content, particularly for subjects where content updating is required on a year to year basis (eg. molecular biology, computer science). To update an interactive multimedia program the programmer must be available to access the source code.
- Expertise to use new teaching tools stays with programmers and screen designers rather than with teachers. The teacher makes little or no progress in the use of interactive media tools.
- As experience has shown teachers themselves are reluctant to use the material as they feel it is not really their material. This applies in particular when the need for amendments or improvement becomes obvious. How many teachers would like to get their overheads or study guides designed and produced by an outside company?
- Student's comments or input can not easily be considered in improving the program.

Content Experts as Multimedia Developers

This paper points out a third possibility for educational institutions to convert content into interactive educational software. If properly instructed about the capabilities of modern multimedia authoring packages, the content expert (teacher) can convert traditional lecture and tutorial material into truly interactive software. (It is only the content expert that knows the students misconceptions and level of on-line assistance needed). Although this requires an initial time investment to familiarize with programs such as *Authorware Professional*, *Hypercard*, *Supercard* or *Toolbook*, it is likely to be time effective in the long run. While many teachers have no hesitations to use modern presentation tools such as *Powerpoint*, they seem to be more reluctant to develop material that allows students a much more active and individual learning approach. With very easy to use authoring tools such as *Authorware Professional* available, this option may not take much more time than the thorough preparation of more traditional teaching aids. By learning how to use such tools the teachers may practise what they preach - life long learning - by keeping up to date with new teaching technologies as the become available. The current trend in such technologies is clearly towards more easy to use authoring tools for web pages and interactive programmes, such that the learning phase is likely to become even shorter. This would mean for the institution to encourage and support a decentralised development of small software pieces by a number of suitable teachers. This could involve supporting general quality insurance, (graphics design, educational theory, debugging help, testing and evaluation, participation in workshops (similar to this conference) etc

Simple Software Implementations that Worked

First Attempts

The first attempts with developing interactive software resulted in linear paging programs (electronic book) that were clearly analog to the lecture presentations (eg. using powerpoint). Students could move from screen to screen by clicking a ‘Continue’ button. This clearly offered students a self-paced approach and the possibility to view the material at the time of their choice. However, after preliminary tests with students, this material was found to be unsuccessful in enhancing students’ learning as many students viewed the material relatively superficially, and ‘skipped from screen to screen in the hope to come across something exciting’. The inclusion of branched pathways and ‘jumping’ to other parts of the program (hypertext links) did not appear to address this problem.

Advancing in the program by identifying items on the screen

In order to force students to take full notice of what is presented on each screen the standard ‘Continue’ button was omitted and replaced by a hidden ‘Hot spot’ on the screen. In a module on the graphical representations of biochemical chain reactions the explanatory text on the screen (equivalent to the lecturer’s comments) asks students (by using coloured text) to identify a particular item by pointing to it on the diagram. Correct pointing (hitting the hidden hot spot) allows the student to proceed in the program while incorrect pointing can trigger a specific explanatory feedback. This relatively small change allowed only those students to advance further that read the comment, reflected about its meaning, and could relate it to the diagram. In comparison with lectures, students can only advance further in this presentation, when they ‘follow’ the train of thought of the author. This could be particularly useful as a replacement of pre-laboratory talks. However there appeared to be a need to get students to think more deeply rather than read, identify, point and browse.

Students Participating in the Development of the ‘Presentation’

In subsequent program modules it was attempted to use the computer program analog to a one-on-one tutoring situation. Instead of presenting a scientific concept step by step in the usual way, the student is asked to guess the next step without having been instructed on the complete the background needed to answer the question. The idea is that the student uses previously attained knowledge and common sense to think about the likely correct answer. Correct responses allow to proceed further in the program, while incorrect responses provide detailed feedback on the students action. After having tried by an ‘educated guess’students are usually more interested in the correct answer and in finding out where their own thinking was not in line with the teachers beliefs (incorrect). Typically the students interact with the program by either keying in a word or numerical answer, plotting a point on a graph, moving an object to a correct position, making a sequence of choices or adjusting parameters in a process simulation. If the answer chosen is incorrect they may be provided with further information that hints at other aspects they need to consider in order to solve the problem or directs them to additional resources within (different module or level) or outside (tutor, textbook, *etc.*) the program.

The concept of this program design (learning from instant feedback) was borrowed from one-on-one tutoring experience (asking 'What do you think ?' rather than simply explaining a concept step by step). Students learn from the instant feedback to their actions similar to a laboratory situation. It is hoped (but not evaluated yet) that this way of helping to construct knowledge gives the student the feeling of owning some of the knowledge rather than 'being filled with knowledge'. One of the aims behind using this approach is to include a constructivist approach of student centred learning.

A further potentially beneficial effect of this strategy could be to identify and utilise individual students misperceptions rather than overrule them by providing the 'correct' concepts.

Advancing by Problem Solving

A simple (in terms of authoring skills needed) but very effective way (judged from students feedback) to develop particular skills in students turned out to be the use of quizzes. After having been introduced to a new science concept, students are asked to apply the new knowledge solving a number of specific quizzes. After having completed a series of quizzes some new information is provided followed by further quizzes. The program records the students score of the quizzes and uploads it to a data file on the web. Upon students' request tokens or bonus points were included to programs that had no visible reward at the end. It was found to be necessary that the program selected the quiz questions randomly from a small database to prevent students from memorising (and also sharing) the correct answer to each screen.

Including a Game Component

In computer laboratories it was observed that many students preferred to use quizzes to guess the correct answers and were not fully focused on 'getting it right'. By contrast the same persons could be seen very concentrated and focused when playing commercial computer games. It was attempted to somehow draw on some of the obvious energy that computer games manage to mobilise from within the user. Realising that the obvious fascination with many computer games is not exclusively to win bonus points but also the exposure to the stress of failing (*e.g.*, loosing the battle against the monsters) a stress component was included in some parts of the program by requesting students to get 10 correct consecutive answers before a bonus 'token' is given. Incorrect answers result in the loss of all credit points (counter is set to zero). The inclusion of this educationally doubtful 'negative conditioning' resulted in markedly higher levels of tension and arousal when students had reached 8 or 9 correct answers and did not want to lose these points by a careless answer. In computer labs they reflected more carefully about the answer and also consulted each other before keying in their answer. In other programs repeated errors (indicating guessing) resulted in shuttling students back to an earlier part of the program. Although not all students expressed their appreciation of these setbacks caused by erratic entries it certainly has resulted in carefully considering each answer.

Providing Tools for Self Directed Learning and Experiencing

Because of individual approaches of different students to conceptualise science principles simple (or complex) simulations have been developed that allow students to change parameters of processes in order to investigate and experience the behaviour and underlying principles of these processes (eg. sedimentation behaviour of particles, titration simulation, chromatography simulation, bioprocess simulation (BioProSim), predator-prey simulation). Such tools were not directly useful to the majority of students unless specific tasks were specified in the program itself or the study guide, detailing the experiments to be carried out. The development of simulation programs can take significantly more time than generating questions and answers for quiz questions. It requires also a good understanding of the mathematics principles that control such processes. On the other hand, students can spend substantial amounts (several weeks) of time on working with such tools at their level of expertise.

From interacting with simulations, students produce assignments (each student works with a simulation that uses different sets of parameters) that can be easily marked by comparing with values in a programmed computer spreadsheet. As an example, a bioprocess simulation model was successfully used to complement true laboratory experiments with simulated data. In student questionnaires students recognised the benefit of combining hands on (and thus error prone) laboratory experiments with error free simulations for the understanding of industrial processes. As the simulation always guarantees a set of useful data for analysis and interpretation there is no necessity for the laboratory component to produce ‘good data’ hence students can be allowed to work somewhat more freely and learn from their own mistakes.

Further Features of Program Modules

- Modular structure of online material to allow for sharing of content between compatible courses. This is essential for all online offered material (in contrast to CD-ROM based software) as the loading time for modules should be kept short (to prevent congestion of modem pool, etc.)
- Easy internet on-line implementation of software pieces via *Shockwave* technology. At the same time CD-ROM versions of the same programs can be distributed.
- Integrated assessment by automated progress tracking and uploading via the web.
- Feel of ownership (avoiding the ‘not invented here syndrome’) of the program by the teacher.
- Possible exchangeability of small modules between different courses.
- Built in recording of student comments for improving and debugging program in the following year
- Randomly generated problems to prevent student collusion
- Teachers develop expertise in using the modern and effective teaching tools. This expertise can expand and spread across campus (e.g. as workshops, etc.)
- Online identification of at risk students

On-line Versus Off-Line Delivery

By using Macromedia’s shockwave technology, the software modules can be directly on line (for examples refer to above URL). However, students typically work through the problem solving exercises off-line. This is because the exercises usually consume more time than most students would be allowed to be linked up to the university server from home. However the downloading of updated modules and the uploading of the students data file (including performance, comments and other results of the program use) can be done online.

It was found that the main time requirements for most software modules were not at the programming level but at the educational level. Such development of programme modules can be a good experience for the development of teaching skills (thinking of students’ misconceptions, preparing feedback for students responses to the program). The time needed to enrich the content of a typical science lecture by web based interactions is estimated to be between 8 and 30 h per lecture. The actual time needed depends largely on the experience of the developer and the availability of program templates. For example, pre-developed templates for randomized multiple choice questions or problem solving and progress tracking routines could allow other staff (also secretaries) with experience in using word processors (e.g. MS-Word) or presentation software (e.g. MS-Powerpoint) to insert their own content (eg. images, text, movie clips, hyperlinks). Usually some trouble shooting (actual embedding on the web, customizing of templates) is needed by staff familiar with the program(s) used.