software for engineering education

Contents

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cti ENGINEERING

Editorial

Welcome to the 14th issue of Software for Engineering Education (SEE). The theme for this issue is **Virtual Learning Environments** (VLEs). VLEs promise to ease both the management and delivery of teaching and learning. Although it is still early days as far as the adoption of such environments is concerned, there is considerable potential and widespread enthusiasm for their increasing use in UK higher education. I hope that the articles in this issue will provide you with a broad overview of some of the activities that are already taking place in the area to enable you to consider how you can incorporate the technology of VLEs.

The CTI/TLSTN Review

As many of you no doubt are aware, following the review (please see **http://www.niss.ac.uk/education/hefce/pub98/98_47.html** to read the review report) of the CTI and Teaching and Learning Technology Support Network (TLTSN), the funding councils are planning to take the support offered by the CTI Centres into a new phase with the establishment of approximately 23 new subject centres. This phase will involve extensive restructuring and the expansion of the remit of the new subject centres to support teaching and learning in all areas of higher education. **A summary of the review findings can be found on pages 37-38 of this issue**. We are particularly pleased to see that the new subject centres include proposals for the establishment of separate centres for each main subject groupings within the engineering discipline as we have long argued that the requirements of each engineering subgroup are different.

Institute for Learning and Teaching (ILT)

The restructuring of the CTI coincides with the release by the Committee of Vice Chancellors and Principles of their conclusions from the various consultation exercises on the ILT that have taken place in 1998. The prospectus, entitled 'Implementing the Vision', follows previous announcements in giving first place to the accreditation function of the ILT or 'enhanc[ing] the status of teaching in higher education' by setting standards of professional practice. To provide a subject focus for the support of learning and teaching, the prospectus looks forward to 'a productive relationship between the ILT and the central management unit envisaged to operate the new subject centre arrangements'. The prospectus 'ILT: Implementing the Vision' is available for download at http://www.cvcp.ac.uk/pubs/ilt2.doc or at http://www.cvcp.ac.uk/pubs/ilt2.rtf for those without Word 97.

The CTI News Service

http://www.cti.ac.uk/news/

We would like to draw your attention to the news service now provided by the CTI Support Service. This service provides information on relevant worskhops, conferences and other events, short feature articles on current issues in C&IT for teaching and learning, including the work of the CTI Centres and related programmes and initiatives and a forum for news, updates and announcements from projects and initiatives concerned with innovative teaching and learning in UK HE.

PRoCeSS - online software database

We are happy to announce the availability of our new online engineering education software database. The database contains over 800 records of software useful for use at university level engineering education and is available on the CTI Engineering web site. Searches can be conducted by package name, engineering subject area, or keyword. CTI Engineering has designed it to be a useful resource for engineering and science-based disciplines. Please feel free to visit the site and let the Centre staff know what you think. The database will be updated every fortnight. More information on the searchable database can be found on page 4.

And finally...

We welcome submissions to SEE - for publishing guidelines see http:/www.ctieng.qmw.ac.uk/cti-eng/publications/newsletters.html. The next deadline for copy is February 26th 1999. The theme will be **Problem-based Learning in Engineering** but we also welcome articles which concern any aspect of the use of computer based learning material with particular reference to its use in Engineering higher education. We especially welcome reviews and case studies of material currently being used in the classroom. Reviews of relevant books and conference reports are also welcome. Please note that we reserve the right to edit contributions where necessary. Authors will receive copy prior to publication and will also receive a complimentary copy of SEE after publication. Contributions will appear in both the print and electronic editions of SEE (http://www.ctieng.qmw.ac.uk/Publications/Newsletters/nlindex.html). For a copy of the centre guidelines for authors please contact me.

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Editor

PRoCeSS (Package and Resource Catalogue Search Script)

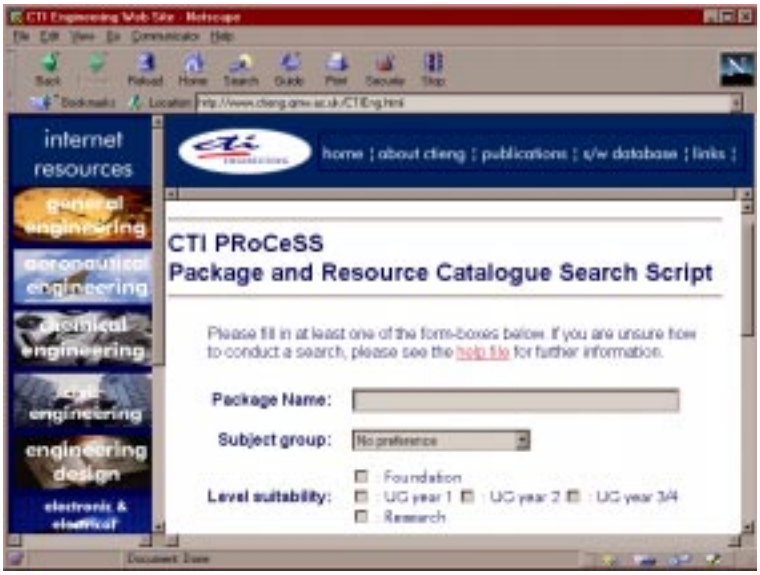

Fig1: PRoCeSS search page

'Having a hard time finding the package you want? 'Finding it difficult to look up software for use in a range of classes?

For some time now, the CTI Engineering Website has been straining under the burden of a large number of Webpages, one for each item of software we have listed, and has also lacked a more rational and refined way to sift through this growing collection of information. As of mid-September 1998, CTI Engineering launched its latest tool to help locate computer-based Engineering teaching software. Called PRoCeSS (Package and Resource Catalogue Search Script), this search engine allows our entire resource catalogue of software to be searched by name, one of thirteen subject-based groups, teaching level, or descriptive keyword. Those 'hits' you choose to keep can either be examined immediately or stored in a 'basket' to be examined along with the results of other searches. Each package in the Resource Catalogue has its own entry, specifying price, description, related resources or links, and reviews (where such links and reviews exist, of course).

The formal release is the front-end to our database of information which is undergoing a full update thoughout this time. We will be pleased to hear from you regarding any 'features' or bugs you find, or any comments or suggestions for future improvements. Please take a moment to fill in the brief questionnaire during one of your visits.

We look forward to your visit to our new search engine, and we hope that finding good software in the future will be a smooth and enjoyable PRoCeSS!

The CTI Engineering search engine can be found on the 's/w database' link from the main Webpage (**http://www.ctieng.qmw.ac.uk/CTIEng.html**) or reached directly at **http://www.ctieng.qmw.ac.uk/cti-eng/cgi-bin/database.cgi**

Fig. 2: Detailed search result

COSE - A Virtual Learning Environment founded on a Holistic Pedagogic Approach

MJ Stiles, Staffordshire University and MP Roach, Warwick University

COSE is a Virtual Learning Environment system (VLE) developed under funding from the Joint Information Systems Committee. The system facilitates the adoption of an active learning methodology. Study support is via specific tutor guidance for the learning opportunities presented, evidence of learning, learning level indication, email for peer and tutor discussions, etc. The importance of synthesis and collaborative working are reflected in the design. The system is designed for distributed learning rather than as a stand alone instructional system.

COSE has been underpinned by the development of a model to assist in the breakdown of courses into the constituent educational skills required. The model provides a coherent set of educational skills and offers a structured approach to enabling independent learning through course design and learning assessment.

A Holistic Perspective of Learning - the COSE Pedagogic Model

The idea of designing learning environments based on a synthesis of many pedagogic concepts has been visited before[1]. Such works give extensive surveys of previous learning theories and 'types' of knowledge. They focus upon the development of 'know-how' (knowledge and methods), although the importance of higher thinking skills to facilitate problem solving has been investigated in some depth[2] [3].

Due to the challenges facing higher education (increasingly evident with a reduction of the unit resource), new modes of delivering learning are being explored[7]. Importantly, the view of higher education's role as primarily delivering know-how is extended into the concept of 'graduateness' or 'scholarship' [8] and cognitive strategies[4,5,6].

The model presented here allows educators to differentiate between *skill training* and *scholarship*. The latter provides a broader scope of educational outcomes than the 'know-how' to work effectively within an organisation. In particular, the model embraces 'scholarship' to include creativity/innovation, understanding/ critical thinking and problem solving/project management/research in addition to know-how as constituent qualities of a graduate. It is proposed that behaviourist learning methods[9] do have their place in the development of 'graduateness' but that (with the introduction of cognitive skills) constructivist learning methods [4] are also essential in the development of certain competencies or qualities.

The behaviourist approach to skills training has two main components, information and methods or 'operations with knowledge'[11] - that is, 'knowing-how'[10]. Information does not become knowledge until it is 'internalised' by the student. Without any familiar context within which to interrelate such information simple memorising is adopted. Implicit in this statement is that no understanding is implied or required. Although this may be a surface form of learning, it is nevertheless adopted by all learners to some degree, whatever their level of expertise.

Higher level learners may analyse new information and modify previously held concepts to assimilate this new information or reject the information (reflection). In spite of this it is clear that 'memorising of information' to develop 'knowledge' is still a real and existing form of learning. Another form of learning (albeit again at a low level) is practising of methods or procedures. Although such practice may not have a real context within which it takes place, it is still a real

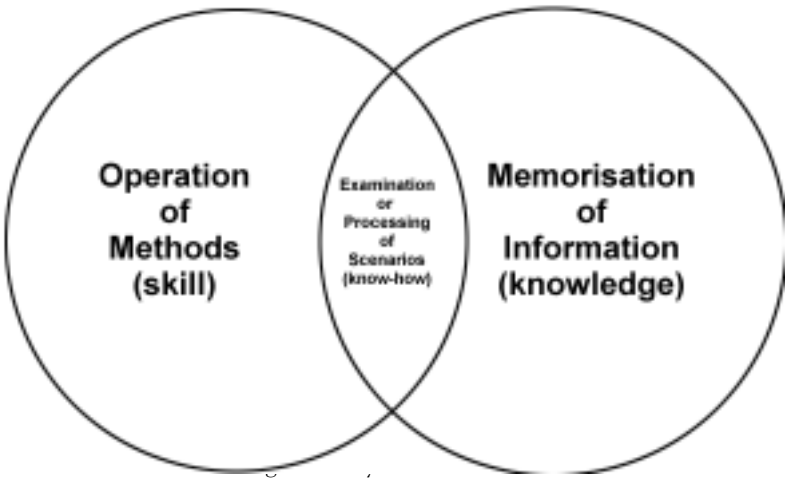

Figure 1: The "know-how" Region

urface learning. This maybe true but behaviourist learning clearly has its place in training.

In terms of motivation of students, the central issue will always be the aspirations of the students and the assessment criteria set down by the course. As such it is argued that the assessment criteria (as part of the educational environment) will have a dominant effect on the learning habits of students. Consequently assessments must be designed to complement and promote the desired learning outcomes.

To develop higher levels of cognition it is therefore necessary to introduce educational activities which require them and to assess them specifically. Consequently the model introduces a domain for cognition (or reflection). Without interaction with methods or information the learning activity is 'reflection' and the learning outcome is 'imagination'. This gives rise to the learner's personal constructs and concepts which they use to relate to the world.

Introducing knowledge to this active cognition domain results in specific learning outcomes and indeed familiar learning activities. The learning activities involved would require explanations/analysis and support of concepts using supporting information, or conversely, the development and argument/critique of concepts based on supportive information. Such learning activities foster the interrelationship of information and thus the development of concepts by the student, i.e. 'understanding'.

Introducing methods into the active cognition domain results in new but again familiar learning activities. If a student holds or develops a concept and is required by some method to produce an exemplar of this concept, then the learning outcome is termed creativity or innovation. Such learning activities include art and design.

The three areas of overlap are termed 'application', as they require the application of each of the three competence domains within a remit or context.

The three learning domains and their intersections maybe represented on one diagram as shown opposite.

The final interaction of these learning zones is termed problem solving or project management. (It can be extended to research when the knowledge base of the individual is extensive enough to encompass the knowledge base of the society in that particular subject).

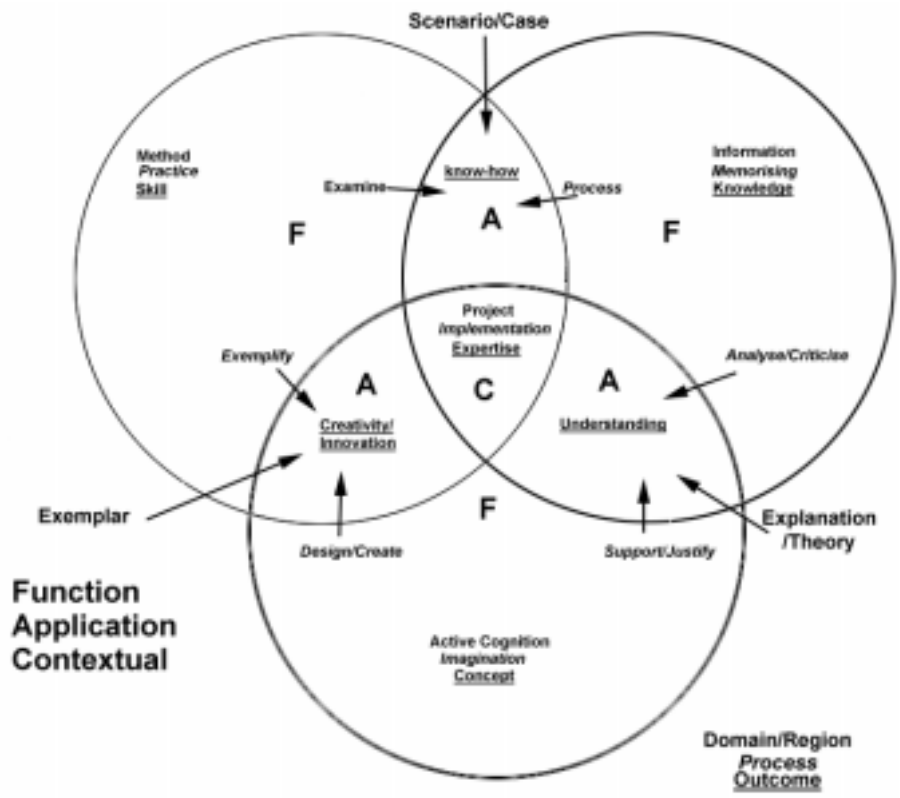

Figure 2: The Three Learning Domains

This final region is context specific in that learners are required to apply the application competencies in real world situations. This would be the region of implementation of a strategy or project. The learning outcome is dependent upon the level of learning, i.e. problem solving, project management, research.

The learning activity for each of the regions is determined by where the student enters that region. For example entering the creativity region from the cognition domain requires that the student find and learn methods required to produce and exemplar of the concept. However entering from the methods domain requires that a student determines the concept which such a method exemplifies. Specific cases include, 'What does this previously unseen piece of experimental equipment measure?'. Conversely, "Design a piece of experimental equipment to measure the speed of light". Both result in entering the creativity/innovation region but one from the given methods domain the other form the given concept domain (i.e. the speed of light). Similar examples can be produced for each of the boundaries.

The basic driving force behind the development of student learning is assessment but is encouraged using appropriate learning activities. The activities can be designed with reference to the learning regions as can the assessment. The assessment trend for the whole model rests on the fundamental questions for all learners: 'What' (knowledge), 'How' (Methods) and 'Why' (cognition). The overlap regions therefore produce 'Know-How', 'Know-Why' (understanding) and 'Why-How' (creativity/innovation). The reason for the lack of use of some of the terms is apparent!

The central region would consider the question 'when?'. The final outcome is the ability to chose the correct method, explanation, innovation for a specific context i.e. implementation.

As most of the above learning activities will be familiar to most educators, course designs based upon the model may well therefore just **explicitly** define and extended activities which already occur. By identifying the existing learning activities of students and courses, they can be designed and developed to facilitate more effective and student centred learning.

Levels of Learning, Collaboration and Synthesis

To enable learners to make the transition from Instruction through Scholarship to Research requires a strategy that addresses the acquisition of tacit knowledge, and which, in particular recognises that students lack those elements needed to address the deconstruction of 'real world' problems.

The COSE model divides learning into three levels[14], the ability to solve bounded problems (level 1), the ability to undertake developmental activities (level 2) and the ability to undertake "real world" projects or research (level 3). Earlier work[3,12,14] has shown that learners at level 1 lack the skill experience to address level activities in an effective manner.

The model shows that the required transition can be facilitated by giving learners opportunities which have been deconstructed for them into lower level opportunities, with the degree to which this has been done being reduced (eventually to zero) as the learner makes the transition from Scholarship to Research. This meets the need[12,14] to provide learners with level specific activities and resources whilst enabling learning to take place in the context of "realistic" learning opportunities.

The relationship between support and collaboration is complex. In terms of communication, learners at lower levels use communication for requesting support and guidance and for peer support, whilst at the highest level the primary 'support' mechanism is discourse. Again, this is a transition which requires management and which needs to be accounted for in the design of courses.

Despite the fact that, in lectured courses, learners can adopt relatively high levels of collaboration and discussion and consequently change learning outcomes from level 1 to level 2, it is often 'more by chance than good course management' and is not an appropriate basis for the design of courses.

It is important, therefore, to facilitate such student collaboration and reward it[15,16]. Collaborative working can provide valuable peer feedback and proof of learning which the tutor would otherwise provide at a 'higher' level through assessment. Such approaches could significantly reduce staff loading with an increase in quality of student learning.

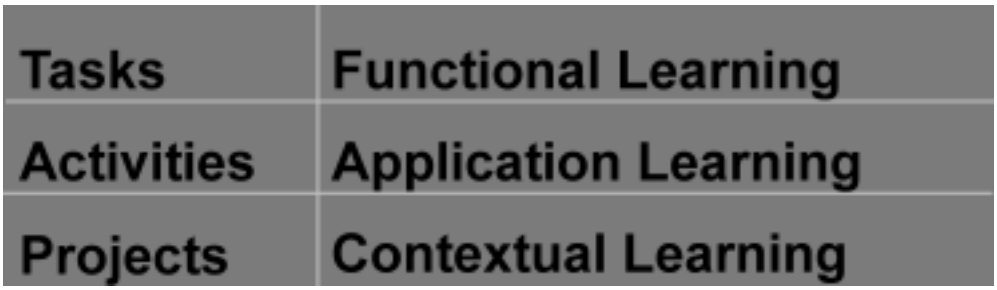

Figure 3: COSE Learning Opportunities

Examination of the COSE model indicates that subject areas tend to focus on some but rarely all of the skill areas. It is probable therefore that level 2 and 3 activities may tend to be cross subject. This is due to the fact that 'real world' problems tend to require a range of tacit knowledge. Facilitation of the synthesis required and therefore of the associated learning skills is hence an important element of course design.

Learners need to develop both the ability and confidence to look beyond their existing subject knowledge and skills when addressing problems, and to be able to recognise when there is a need to collaborate with others possessing different capabilities.

The COSE Virtual Learning Environment

The COSE pedagogic model has a clear focus on the development of tacit knowledge and the ability to deal effectively with realistic learning opportunities. With more open-ended problems the required subject resources are much less well defined which can be a cause of concern to both the learner and tutor. The delivery of resources and the careful selection of learning opportunity therefore take a high priority. Once learner motivation to address the learning opportunity is established, the relationship between the opportunity and the required resources has to be established, as do the relationships between the differing resources.

The Course Design Process

In order to address the differing needs of learners at different levels, and to facilitate the various required transitions and development of tacit knowledge, the following is proposed as a functional, albeit pragmatic, method of course design:

Learning Outcomes - Here, a desirable start is a clear perception of what the **point** of the course is i.e. in what way is a learner changed by successful completion of the course? Whilst this requires that outcomes must be demonstrable, a narrow emphasis on behavioural objectives is insufficient. In order that Outcomes can be demonstrated in context, it is important to consider such things as the benefits, competencies and capabilities that a learner should acquire.

Learning Opportunities - These should be developed with the view that a Learning Opportunity is something that a student can do, and which, if done successfully, will demonstrate that one of more Learning Outcomes have been met. Regardless of level, the emphasis should be on 'real-world' or, at least, 'realistic' opportunities. Problems associated with lack of tacit knowledge can be dealt with by the next stage.

Learning Level - Examination of a Learning Opportunity in the context of the COSE pedagogic model will establish what learning domains are being addressed and whether the opportunity constitutes Function, Application or Contextual learning. Depending on level of the learner and the amount of guidance and support it is thought appropriate that a learner is to be given, higher level opportunities can be pre-deconstructed into lower level opportunities for the learner to a greater or lesser extent. Even in the case of relatively 'open' opportunities in which a learner is expected to deconstruct themselves, prerequisite learning outcomes should be identified and opportunities addressing these made available.

The COSE system characterises the different levels of learning opportunity as shown in fig 3above.

Collaboration - Following any pre-deconstruction each opportunity can be examined for its potential collaborative

content. Collaborative activity can be assessed in differing ways depending on whether the output is individual or group, and whether learners play similar or distinct roles within the activity. The degree to which support and guidance is required is again dependent on the learning level.

It is possible to make the development of resources by learners an active component of a Learning Opportunity. This might be by group research for, and critical evaluation of, WWW resources, or by electronic discussion and the collaborative summary of its conclusions.

Resources - The COSE system differentiates resources as being Theory ('Codified', or subject-specific, information), External resources (Reading lists, WWW resources, and Lectures) and Hints (Procedural guidance - 'have you considered this approach?', 'one way of tackling this might be...' etc.). Note that placing individual lectures (or videos) in the context of specific learning opportunities can result in a more positive approach to them. It is worth considering at this point if any lecture proposed has a distinctive focusing, aspirational, inspirational or motivational aspect, or whether it is largely about information delivery, in which case it may well be effectively replaced by resources within the COSE system.

COSE System Facilities

The COSE[17] system has been designed to enable the authoring of study environments, which, particularly when used with courses designed using the COSE pedagogic model, make learning an active, focused, and collaborative process which can be delivered in a distributed manner.

The COSE system has some distinctive design characteristics, namely:

A Course

A course in COSE is a group of learners, rather than a collection of content. The mechanism throughout is one of giving people learning opportunities, rather than assigning people to a collection of content. This enables the learning process to be much more flexible, and facilitates tutors wishing to deal within any learner as an individual (e.g. for remedial purposes)

Content Structure

This is designed to match the COSE pedagogic model and course design approach. Content is made up of:

- Learning Opportunity Pagesets that describe, according to the learning level, the Task, Activity or Project
- Theory Pagesets which supply subject information
- Hint Pagesets that provide guidance and advice
- Internal Resources that are references to pre-deconstructed components of the Learning Opportunity, or opportunities which are related or prerequisite
- External Resources - references to Internet resources, books, journals, lectures etc.

A Learning Opportunity consists of a Pageset of pages where the main text objects describe the learner remit. Each page can include stand-alone media

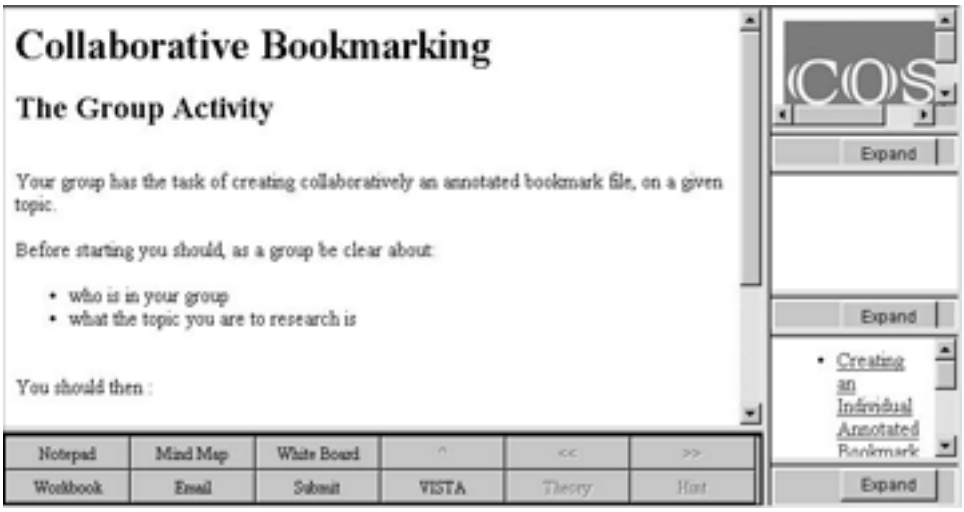

Figure 4. the COSE Learner Browser

objects, an index of internal and external resources, and have relevant Pagesets of Hints and Theory attached.

Low IT Skills Requirement
COSE requires only basic text editing skills, use of point and click, and filename entry. Content can be created using any program capable of saving output as HTML.

All content is standard HTML and media files. To include a Media Object (image, sound, video etc.) the user imports it from their local disc by identifying its filename.

form of quality control over published material.

Collaboration for all

Tutors and learners can develop content together by selectively making 'Work-in-Progress' available to other learners and tutors, individually or in groups.

Tutors create and manage Learner Groups and Subgroups and assign Learning Opportunities to these groups. Learners can search the published content and self-assign learning opportunities and can create and manage their own Peer Groups. Thus,

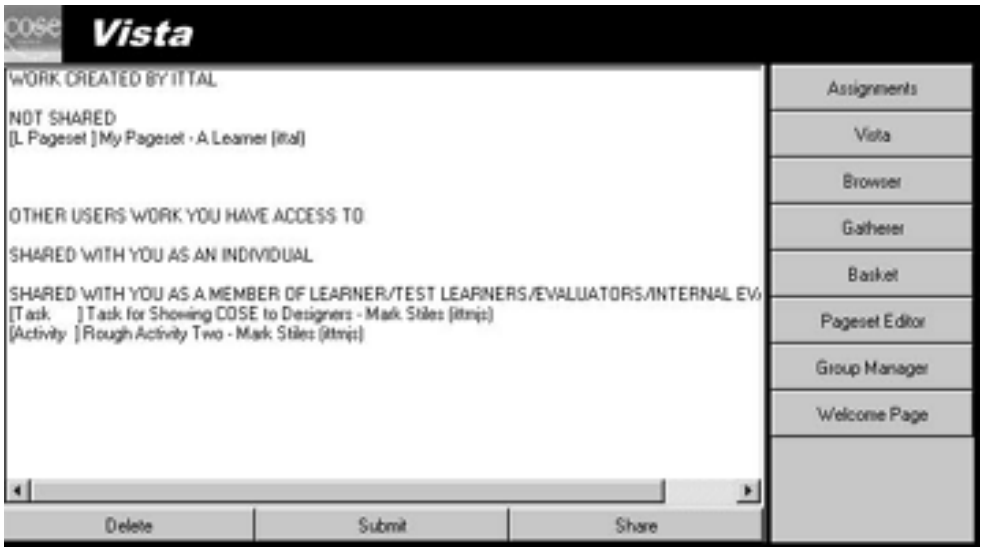

Figure 5. the COSE Learner Vista

The system then carries out the creation of the HTML 'wrapper' and indexes the object within COSE. Text objects can contain in-line media (not 'wrapped') and external WWW links. Any WWW usable medium is acceptable.

Publication and Quality Control
The status of content is either 'Work in Progress' or 'Published'. Work in progress is course material (tutors) or learning taking place by students. Published work is COSE Learning Opportunities and Resources available to all (published by Tutors) or evidence of learning (submitted work by students - this must be republished by a tutor before others can use it). There is only one instance of a published object within the system, hence the editing of a published object gives new, separate 'edition'. Content must be approved before publication. Group editors can be assigned the task of publishing, allowing a

COSE facilitates collaborative learning locally (in 'collaboratories') or remotely via the communications facilities.
An email address book, attached to the COSE Group and Content indexes, enables a learner to email selectively the content author, the tutor who assigned them the content, their course group, collaborative group or peer group.

Sharing and Re-use of Content
All published content is available for re-use at the Pageset, Page or Media Object level. All content is described using metadata from a constrained list plus individually chosen 'custom' keywords.

Learners/Tutors can search for content and 'gather' Pagesets, Pages and Media Objects in a 'Basket' for re-use later in their own material.

As the COSE resources are developed it is likely that 'critical mass' will result. At this

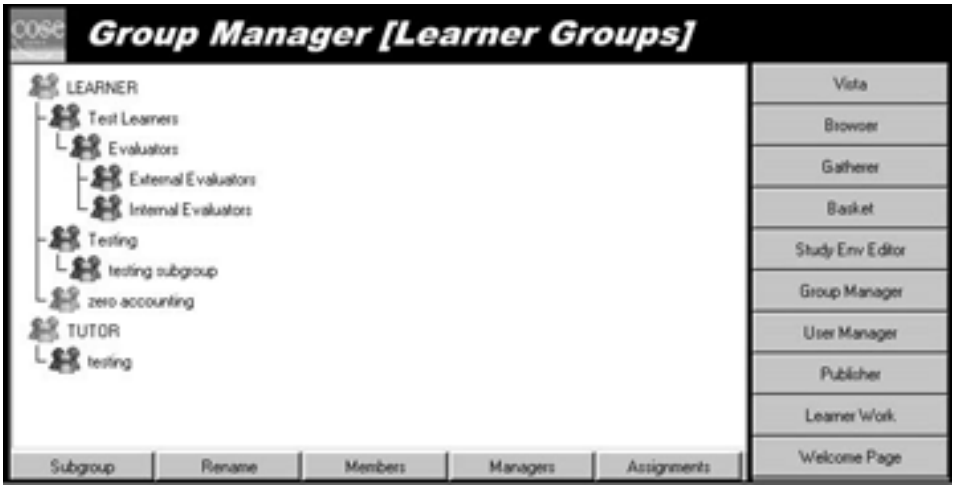

Figure 6: The COSE Group Manager

point the COSE resource base will become a true constructivist learning resource where information is available in all subject areas and subject boundaries will break down. This will promote a re-focus on the skills developed by students and a greater emphasis on activity design rather than specific subject knowledge. COSE is also capable of tracking the system's use by students as an aid to the evaluation of course design and content effectiveness.

Technical Requirements

COSE has been designed to be a low-cost system with low support and infrastructure requirements. It is written using Java and CGI/Perl and runs on a standard http server under UNIX, Linux or Windows NT. Access to a COSE installation is via standard Web browsers (Netscape and MIE) on a PC or a Macintosh.

Note: The images of the COSE system are taken from its Beta 1.2 version. A full release version, COSE 1.0, with an improved interface and a significant number of functionality enhancements will be available free (excluding media and shipping) to UK HEIs in late 1998. COSE will be commercially available to other sectors.

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ALT-C 99, 21-23 September 1999

The last decade has witnessed extraordinary technological developments. For any new technology to be used to enhance the quality of learning it must be effectively integrated into existing curricula. ALT-C 99 will examine the life-cycle of learning technology, from initial design through to implementation, and will include associated issues of policy and staff development. It will bring together participants with an interest in learning, teaching and technology. You are invited to submit one or more proposals related to the conference theme as follows: paper sessions, interactive presentations, discussion groups. Selected papers resulting from paper sessions and interactive presentations will be published in ALT's peer-reviewed journal, ALT-J. Selected papers from discussion groups will also be published. ALT-C 99 is hosted by the CTI and ILRT, and will be held at the University of Bristol.

Contact: inanyeventuk@msn.com

3rd Conference on Engineering Education: ICEE'99, 10-12 August 1999

The ICEE 97 in USA was an important forum for disseminating information on engineering education at the turn of the millennium and for generating opportunities for international collaboration. The ICEE 98 in Brazil was assumed in strengthening alliances that addressed both the bottom-up and top-down streams of collaboration, including graduate education and research, undergraduate studies and new forms of government-industry-university collaboration in engineering education. We propose to make ICEE 99 a forum for further strengthening alliances, bringing new partners from Western, Central and Eastern Europe and the restructured Czech industry.

Among others, the following topics are opened for discussion and investigation:

- innovating curricula content and structure;
- entry-level course design;
- multi-disciplinary design integration;
- applications of new communication and information technologies in teaching and learning;
- multimedia teaching tools;
- distance learning;
- quality methods in teaching;
- models for higher education in various countries;
- integrating laboratory instruction;
- current trends in engineering education;
- university-industry joint programmes;
- practice-based engineering education;
- integration of basic sciences (chemistry, physics and mathematics) and engineering;
- present and changing status of engineering education;
- entry-level engineering;
- global engineering practice, design of co-operative networks for engineering education development;
- mobility of students and teachers;
- foreign languages and social sciences in engineering education.

Abstracts should be submitted to:
Andrea Krizakova, ICEE-99 Secretary
VSB-Technical University of Ostrava
17. listopadu 15, 708 33 Ostrava-Poruba
Czech Republic; **Email:** icee99@vsb.cz

http://www.fs.vsb.cz/akce/1999/icee99/welcome.htm ICEE'99

Civil Engineering Learning Technology in Cardiff (CELTic), 8-10 September 1999

The purpose of the symposium is to bring together all those who are interested in the development and implementation of Learning and Teaching Technology for Civil Engineering education and formation (professional development).

The conference will facilitate the sharing of experience, knowledge and expertise in technology based teaching and learning and its application to Civil Engineering. The event will provide a forum for the presentation, demonstration and discussion of issues related to the application of computers, communication and information technology to professional engineering education. Contributions from associated fields are also encouraged.

Papers are solicited in the following areas but these are for guidance only and are not meant to exclude other related topics:

- institutional strategies
- courseware development
- integration into the curriculum
- internet based education
- assessment strategies and evaluation
- professional development issues

Further information: Cherrie Summers
Conference Secretariat, Cardiff School of Engineering, PO Box 917, Newport Rd, Cardiff CF2 1XH, Wales; Tel: +44 (0)1222 874421
Email: SummersC@Cardiff.ac.uk
http://www.cf.ac.uk/uwcc/engin/celtic/

Solving the Bandwidth Bottleneck: A New Approach to Delivering Rich Multimedia

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Thomas Edison State College's (TESC) decision to use Web-iV technology to deliver courseware to our students at a distance places us, we believe, in a unique niche among college-level distance-education institutions in the United States. We base this belief on the observation that there seem to be only two types of courses generally present on the Internet today. They are characterized by either (1) text-and-graphics websites that are nothing more that online textbooks or reference materials (electronic page-turners, if you will); or (2) streaming video clips taken from an instructor's videotaped lecture or re-purposed from an educational video created for another medium, such as TV or VHS tape. In the former case, students may well be better and more efficiently served via the print medium. In the latter case, students are asked to watch video confined to only a quarter of the screen and playing at 5 to 10 frames per second, with the result that the images are difficult to see and out of sync with the audio. While in both of these cases it may be arguable that the course is 'Web-delivered', in neither case is the course content presented in a format that is conducive to learning at a distance. Much of the reason such courseware is so difficult and frustrating for students to use is that rich multimedia cannot be transmitted without its encountering the 'bandwidth bottleneck'. The Internet's 'plumbing' is not big enough to sustain the data rates needed to move large multimedia files.

Thomas Edison State College wanted to offer Web-delivered courses that go beyond the usual types just described. We wanted coursework that actually engages and teaches the students by showing them realistic video integrated with highly interactive applications and forcing them to participate instead of sitting back and simply watching the lesson. As we discovered when we designed our 'Ethics for Managers' course to make use of Web-iV delivery, Web-iV, with its ability to circumvent the bandwidth bottleneck, can provide us with the means to achieve our goal. Because this was a new area for us both technologically and in terms of course development, we were faced with a variety of challenges and learning experiences. However, we believe that we have succeeded in providing an "Ethics for Managers" course that makes optimal use of technology in the service of intellectual content.

The Challenge

Thomas Edison State College's approach to higher education is fairly unusual in the United States. The College offers courses that are delivered in nontraditional formats to nontraditional students. The College has recently expanded its offerings to include a Master's Degree program, and it is this program that has been the first to offer Web-based courses.

Thomas Edison State College Student Profile

Thomas Edison State College is one of the 12 New Jersey public colleges offering baccalaureate degrees. It also offers the Master of Science in Management (MSM) degree. Thomas Edison State College is unique in the States in that it, like the British Open University, offers all of its degrees entirely at a distance. Courses are delivered in a variety of media, but until recently, most courses have been entirely print-based (albeit with accompanying videotapes), or print-based with electronic conferencing and lesson-submission elements. The College is also unique in that the average age of our students is 38, and we have tailored all of our credit-bearing options specifically for working adults.

MSM Student Profile and Faculty Expectations

All students in the College's Master of Science in Management degree program are required to have access to computer hard- and software to complete their course work. All students have Internet access, all have access to various computer-based conferencing systems, and all must participate in course activities that require electronic conferencing, electronic assignment submission, and electronic interaction with instructors and other students.

The MSM faculty want to make best use of the Internet for the delivery of rich multimedia (e.g., videotaped segments) to present course content. They also want to exploit the Internet's capability to provide links out to

relevant websites to present updated information 'just in time', and in ways that they can modify and manipulate. Finally, they want their students to be able to communicate with them and with one another electronically without having to make cumbersome switches between and among materials and technologies.

The MSM 'Ethics for Managers' Course

The 'Ethics for Managers' course, which all MSM students must take, has content that is best presented in dramatised scenarios and in case studies. Students must consider, analyse, discuss, and make reasoned choices about these scenarios and cases. The course faculty member and instructional designers decided that presentation of this material was best made in videotaped 'dramatisations'. They also identified a need for interactivity as students make choices and receive feedback on those choices, as they collaborate on course assignments, and as they communicate with faculty. Therefore, we concluded that Web-iV delivery was a natural solution to the problem of making this course available via the Internet. And because MSM students already have access to the hard- and software necessary to take advantage of the Web-iV delivery mode, Thomas Edison State College embraced this technology as the one best suited both to course content and student audience.

The Technical Tools

In this course, students and faculty need access to course content delivered via rich multimedia (video, audio, graphics, etc.), but they also need to use the Internet for communication with other websites and with one another in order to fulfill course requirements. Therefore, we needed a technology, a plug-in that allows us to integrate high bandwidth content into a website. That technology is Web-iV.

Web-iV and the 'Server-centric Hybrid'

To deliver the 'Ethics for Managers' course, Thomas Edison State College formed an academic-to-private-sector relationship with Midi, Inc., of Princeton, New Jersey, to implement a 'server-centric' hybrid. In this context, a 'server-centric hybrid' can be understood to comprise applications that access a local storage device and quickly display high-bandwidth materials like full-screen video, animations, or high-resolution graphics. These HTML-based applications must be carefully crafted to ensure fast delivery of the low-bandwidth materials and the seamless integration of the high-bandwidth content. Depending on the PC and the nature of the network connection, one can view a full-blown multimedia application with the low-bandwidth materials being delivered from the Internet and the high-bandwidth material coming from one's CD-ROM, hard drive, or LAN video server.

Students need a computer that meets certain hardware and software standards, including the ability to play full-screen, full-motion MPEG-1 video. The Web-iV approach to solving the bandwidth problem involves enhancing a website to point to multimedia content stored on a local drive. Web-iV lets users who have graphics and MPEG-1 software play full-motion video files, or even interactive multimedia applets featuring full-motion video and high-resolution graphics, in the browser window seamlessly and instantly. The Web-iV approach uses a browser 'plug-in' and JavaScript that allows a user to tell the website the drive where the multimedia content is installed. The website's links are then automatically customized to access high-bandwidth content on the user's CD-ROM drive.

When they enroll in the course, students are provided with a website address (i.e., the Thomas Edison State College course homepage) and a CD-ROM. Before visiting the course website, students must install the CD-ROM on their machine and load the Web-iV plug-in. When they arrive at the course website, they are asked to designate their CD-ROM drive before beginning the course. The course website features links to high-bandwidth content (e.g. video, audio, and high-resolution graphics) accessed from the CD-ROM through the Web-iV plug-in, allowing this content to be seamlessly integrated into the online course.

The resulting 'server-centric hybrid' course delivery combines the strengths of the Internet with the strengths of high-bandwidth visuals to create a powerful teaching tool. The Internet allows Thomas Edison State College to use its server to provide up-to-date course information (such as syllabii, assignments, and instructor notes) as well as the opportunity to communicate directly with other students and faculty via e-mail, bulletin boards and online discussion groups. The addition of the high-quality, high-bandwidth visuals on CD-ROM (full-screen, full-motion video, audio and animations) introduces an engaging course component that is more realistic and powerful than current Internet 'streaming' technologies. This combination of server-

delivered and CD-ROM-delivered elements allows Thomas Edison State College to offer a compelling and effective distance- learning course.

Minimum System Requirements

Minimum hardware and software requirements are as follows:

- 166 MHz Pentium computer
- CD-ROM drive
- An Internet connection
- Version 4.0 of either Netscape or Internet Explorer
- Displays capable of 800 x 600 resolution and 64K color
- ArcadePak MPEG-1 Player by Mediamatics

Since all of the hardware and software specific to the Web-iV delivery method are resident on the 'client' side, the Thomas Edison State College server functions as it does for all of our other electronically delivered courses. For this course, as for our others, the College server provides enrolled students with Internet access, e-mail/chat, and basic course information.

Elements on the Thomas Edison State College Server and Local CD-ROM, Respectively

In the 'server-centric hybrid' model, there are various elements that are resident either on the College server or on the student's local CD-ROM drive. Elements on the College server are those that need updating by the faculty member and/or that allow for student communication with instructors, other students, or other relevant websites. The course syllabus, assignments, and additional commentary from the instructor (all of which are largely 'print based') are housed on the College server, and the server also provides links out for communication. The local CD-ROM, on the other hand, contains the high-resolution graphics, the video and audio clips, and the interactive elements that are 'internal' to the courseware.

The Web-iV technology allows for seamless, transparent integration of all course elements, regardless of their location. It also allows for seamless interaction between the CD-ROM and the course homepage/website. Students using the materials are unaware of the origin of the various elements, since the movement back and forth from server to CD-ROM, is transparent. All instructional sequences are, however, controlled from the Thomas Edison State College server.

The Course Selection and Development

Course Selection

The 'Ethics for Managers' course was chosen as the College's first course for multimedia, Web-iV development and delivery, largely because (as has been pointed out above), it is offered in a program whose students have ready access to the hard- and software appropriate to this type of delivery. However, the course was also selected because its content lends itself very well to the various types of media (video, audio, interactive elements, graphics) that Web-iV technology can deliver. That Midi Inc. also already had some of the video segments 'in the can' and ready for re-purposing in their multimedia library was most appealing on a cost-containment level. And, finally, that we had an enthusiastic Ethics faculty member willing to work with us was a most important practical consideration. We are looking forward to this faculty member helping us to inspire and teach his colleagues as we prepare to select and develop still other courses that will be designed and delivered using Web-iV technology.

Development Team and Role

The Development team's composition reflected a vendor-to-client relationship between Midi Inc. and Thomas Edison State College. The Thomas Edison State College course development team comprised the Director, Distance Education Programs, Center for Distance & Independent Adult Learning, a member of the Philosophy faculty; an instructional designer, an academic media specialist, and a member of the Management Information Systems staff. The Midi team comprised a Project Manager, graphic designers, production artists, HTML authors, and programmers. Teams worked both independently and in partnership as the various phases of the project demanded.

Responsibilities of the Thomas Edison State College team were as follows:

- Select course content, student activities, and assessment methods and

elements;
- Apply instructional design for students at a distance;
- Select appropriate delivery media and advise Midi staff regarding the re-purposing of existing multimedia assets such that they are appropriate for graduate-level education;
- Create a course home page for *Ethics for Managers;*
- Work with Midi to embed multimedia links into the appropriate web pages;
- Assist Midi with website standards and consistency issues for the multimedia segments;
- Ensure that the faculty member is trained to use the current asynchronous conferencing system and that the system is available for the course;
- Ensure that students have appropriate MPEG-1 playback capability and provide them with technical support.

For the Thomas Edison State College team, one of the great challenges was to ensure that our faculty member had the optimal choice of media available to deliver the various types of course content. Once the general course content and infrastructure were determined, the instructional design process was largely focused on appropriate media selection. That we had high-resolution graphics, full-motion and full-screen video, audio, and the interactive elements shown in the 'demo' available in addition to the 'usual' print, was a great boon. We were able to deliver more types of content more effectively, and we believe that we are also able to cater for a greater variety of learning styles. However, we discovered that we, and especially our faculty member, had problems disciplining ourselves when faced with the greatly expanded range of multimedia choices that Web-iV technology makes possible. We needed to remind ourselves that a more conservative approach was sometimes not only more cost-effective (e.g. we needed to confine the content to a single CD-ROM), but it was also in the best interests of ease of use for our students. We also were sensitive to the fact that a more conservative approach (e.g. print) may also be (in certain aspects of the course) more appropriate to the content to be delivered. A major challenge was to be scrupulous in allowing the content and the needs of our students to drive the media selection, rather than having this work the other way around.

Responsibilities of the Midi team were as follows:
- Work with TESC to modify current Web pages for access to multimedia content;
- Design/develop approximately five to six screens per multimedia segment in consultation with the faculty member and TESC technical personnel;
- Provide the JavaScript for the web pages on the server and the plug-in needed on each client computer in order to run Web-iV;
- Deliver re-purposed audio/video clips and high-resolution graphics from existing, Midi-produced interactive training modules;
- Supply basic technical support and documentation to TESC personnel;
- Specify minimum hardware requirements for student users;
- Supply copies of a CD-ROM containing the audio/video and any necessary high-resolution graphics;
- Provide administrative and project management support.

For the Midi team, one of the great challenges was helping the Thomas Edison State College team understand what the delivery possibilities are with Web-iV, how the technology works, and how to help the faculty member feel comfortable with the delivery mode. The Midi team also needed to assist Thomas Edison State College technical personnel establish the course website and prepare a simple tutorial for students who are using the technology for the first time. Perhaps the greatest challenge for the Midi team was the re-purposing of pre-existing materials and creating the 'shell' for the Thomas Edison State College course within the established budget for the project.

The vendor-to-client relationship between Midi and the College seems to have worked very well. Having observed experiences of other distance-education institutions that are developing and delivering multimedia courses for college-level credit, we were convinced that an in-house attempt to create the technological infrastructure necessary to produce viable multimedia courseware would have been excessively costly in terms of both time and of money. We concluded that forming a partnership with a provider of sophisticated educational technology would be of great advantage to us. And we concluded that it would allow us and our faculty to do what we are good at (developing course content and applying instructional design) even as we draw on our partner's technological ability to execute and

deliver our demanding electronic multimedia development and design requests. We found our conclusions to be correct.

Specific contractual and copyright issues are still being worked out and agreed upon by both parties. However, we anticipate continuing to work with Midi on similar projects related to other courses in the future.

The Future

We believe that this first venture into the Web-iV delivery of our multimedia courses will provide us with immediate, positive results. Based on our experiences with Ethics for Managers, we believe that if we replicate the process and work with Midi to design, develop, and produce still other courses,

- our students' learning experience in multimedia courses will be enhanced by the introduction of high-resolution graphics, video, and audio elements;
- our faculty will have the widest-possible range of electronic multimedia teaching "tools" available for presenting course concepts; and
- the College's course-development staff will be able to gain transferable, low-risk experience in high-tech delivery of course content.

Perhaps most significant, however, is the potential this project has for positioning the College strategically in the increasingly competitive distance education marketplace, while at the same time providing superior coursework and educational experiences to our students.

CADIT - Interactive Tutor for Learning CAD
http://www.archit.ncl.ac.uk/sess/index.html

CADIT, from the Department of Architecture at the University of Newcastle, provides a tutorial on CAD, based on AutoCAD. The tutorial covers: preparing to design; 2-D design; editing design; advanced editing; editing polylines; display controls and viewports; object snap and inquiries; 3-D design; advanced 3-D design; viewing 3-D design; paper space and plotting; hatching and text; dimensioning; tutorials; and blocks and attributes. An overview of a GIS tutorial is also given.

Chemical Engineering Materials
http://www.tulane.edu/~bmitche/book/

Chemical Engineering Materials is an electronic book on the fundamentals of materials science designed specifically for chemical engineers. It is intended to utilize the multimedia capabilities of the Internet, to help the user more easily learn some of the concepts of materials science that are best taught visually, e.g. crystal structures. At the same time, topics such as phase equilibria and mechanical properties are presented in a more traditional, 'textbook-like' manner.

Engineer On A Disk
http://claymore.engineer.gvsu.edu/~jackh/eod_new/

The Engineer On A Disk site provides a series of notes on a wide range of engineering topics. These include:

- automation
- computer hardware
- design
- electrical
- engineering
- manufacturing
- materials
- mathematical modelling
- mechanical
- mechatronics
- quality assurance (SPC)
- software

The Expert System for Thermodynamics
http://eng.sdsu.edu/testcenter/

TEST assists in solving problems encountered in Engineering Thermodynamics textbooks and in real world situations involving HVAC, Combustion, High Speed Flows, Gas Mixture, Steam Power, Vapor Compression Refrigeration, Power Cycles, Gas Turbines, Turbojets, Pumps, Compressors and much more.

Manufacturing Education
http://www.mfg.mtu.edu/marc/primers/

The Manufacturing Education Page is focused on providing manufacturing-related educational materials. The materials may be used to supplement existing manufacturing courses or may assist students/engineers in self study. The Manufacturing Education Page consists of three sections: Manufacturing Primers, Software Testbeds, and Manufacturing Education Chat Room.

Twisted Pair
http://www.twysted-pair.com/

Twisted Pair is a site for those with an interest in electronics. Here you can ask questions, find answers, research reference material, locate books and download interactive multimedia tutorials.

Patent Searching Tutorial
http://www.lib.utexas.edu/Libs/ENG/PTUT/ptut.html

This Patent Searching Tutorial teaches the basics of patent searching. The specifics were written for patrons of the Patent and Trademark Depository at the Richard W. McKinney Engineering Library, the University of Texas at Austin, but users will learn how to conduct an invention search, and by the time they are finished, they should be able to conduct a basic search to determine if an invention has already been granted a patent in the U.S.

Virtual Laboratory
http://www.jhu.edu/~virtlab/virtlab.html

The Virtual Laboratory is a virtual engineering/science laboratory course produced by Michael Karweit at the Department of Chemical Engineering at Johns Hopkins University. The objective of the course and the virtual laboratory is to introduce students to experimentation, problem solving, data gathering, and scientific interpretation early in their careers-perhaps as sixth form students or 1st year undergraduates.

MTUTOR: a tutorial shell for supporting problem solving

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MTutor is a World Wide Web based tutorial shell that assists in the formation of problem-solving strategies and design competencies. It aims to automate student-centred problem-solving skill development through the following objectives: to improve student problem-solving strategies, to increase student-domain knowledge, to maintain staff contact through a tutor's discussion of possible solutions, and to provide a common experience across the student cohort. These objectives are supported in a tutorial-style learning environment with automatic student assessment and immediate feedback of satisfactory solutions developed by the tutor. On completing a tutorial the system allows the student access to a discussion group to which peers and tutors alike may contribute.

MTutor has been evaluated in the laboratory and is now undergoing extended trials with fourth-year undergraduate Electronics Engineering students. It is also being applied to problem-solving tutorials in Geography, Geology and Psychology within the University of Plymouth.

Students learn facts and figures by rote and problem solve by algorithm and rule-of-thumb as presented by their tutors. Over their undergraduate years they become proficient at recalling and applying detailed knowledge in many domains. This is in preparation for real-world problem solving which is often characterised by its complexity, ill-defined requirements and novelty of solution. In Higher Education small group tutorials are the main vehicle for further improving problem-solving skills but unfortunately these are labour intensive and have some shortcomings. Given the correct model, computer tools can address these issues and can provide a good substitute for small group tutorials.

Reviewing the tutoring of new knowledge and problem-solving skill it seems that a student acquires a breadth of knowledge through a series of taught modules, each covering a specialist topic. Using the example of learning how to design pencils, a possible student-learning experience can be explored.

Technology-supported learning tools to address these competencies are readily available. They provide knowledge acquisition and rehearsal over a wide variety of topics. Such systems are exemplified by the first computer based system called Plato, whose development started in 1960 by Bitzer[1]. This type of system has been widely applied and now employs sophisticated multimedia techniques to animate concepts and provide new ways of tracking student progress. However the acquisition of problem-solving skill is different, since to be a useful problem solver one may have to address novel problems that straddle domain boundaries. This requires the acquisition of more knowledge and different tutoring methods.

Simon and Newell[2] define problem solving through the concepts of means-end analysis and problem spaces. They proposed that general problem solving involves the identification of sub-goals and the use of methods to satisfy sub-goals. Problem-solving skills also appear to be related to other aspects of human cognition[3] including schema (familiar problem elements), pattern matching (recognising familiar problem elements), and creativity (developing new solutions).

Fig 1 depicts a simplified problem-decomposition/ solution-synthesis tree diagram for the design of a pencil. Knowledge from each of the vertical threads become useful in isolation; in solving sub-problems (goals) in the definition of the pencil body, its lead, its shape and its length.

Studies of problem-solving strategies in experts and novices reveal a difference of strategy when faced with novel problems. Both novices and experts progress in a top-down fashion but novices prefer a depth-first path whilst experts tend to a breadth-first path in both problem decomposition and solution synthesis[4]. With reference to Fig.1 novices will prefer to define the body of a pencil completely before moving on to exploring possible solutions for the lead, the shape and length, attending to each major sub-problem in isolation from the others.

Experts, on the other hand, will attend to the lead, shape and length of the pencil whilst developing a solution to the body of the pencil. Novices do not have the depth of knowledge that experts possess. This makes a novice less confident of the detail of a solution and therefore there is no focus on the important boundary conditions where solution blocks joint together. Thus novices are more likely to develop solutions with faults at the boundaries between blocks. As novices have limited domain knowledge, they will also tend to only consider one solution: research suggests that the first solution to come into their heads is the one taken to completion. This is poor practice.

So how can novices become experts? Stoner[5] (1992, chapter 7)suggests that practice is required, but with timely feedback and support from their mentor to encourage good and suppress bad practice. He also suggests 'varied experience is the key to learning the abstractions and skills that enable learners to cope with novel situations'. He reviews the main activities that offer help in developing effective ways of solving problems. These include (i) identifying the problem, (ii) bringing to mind the relevant concepts and principles, (iii) analysing the task, (iv) giving prompted practice and (v) developing independent activity. Tasks (i) to (iv) mirror the top-down methodology observed in expert problem solvers. Unfortunately the inclination of students is to seek the detail rather than an overview at the start of a problem-solving session, "Students often just pick up a pencil and paper and start solving the problem without serious consideration of the requirements and constraints'[6]. MTutor is an attempt to alleviate this.

MTutor

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- to improve student problem-solving strategies; to increase student-domain knowledge;
- to maintain staff contact through a tutor's discussion of possible solutions;
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These objectives are supported in a tutorial-style learning environment with automatic student assessment and immediate feedback of satisfactory solutions developed by the tutor. On completing a tutorial the system allows the student access to a discussion group to which peers and tutors alike may contribute.

MTutor draws its inspiration from the music master-class, where a student plays a piece of music for the tutor, the tutor assesses the performance and then plays the piece back to the student. The student compares her or his performance to that of the master and improves by learning the difference. Following this master-class analogy, the MTutor system can set a problem, provide an information resource, require a written solution by the student, ascertain the student's solution via a questionnaire, assess their performance and award them a mark. Finally it can define what was expected of the student through the presentation of valid solutions. Students still having difficulty or who would like to contribute to a general discussion on the topic with their tutor and peers can post questions or comments to a discussion group in the form of an on-line bulletin board system controlled by MTutor.

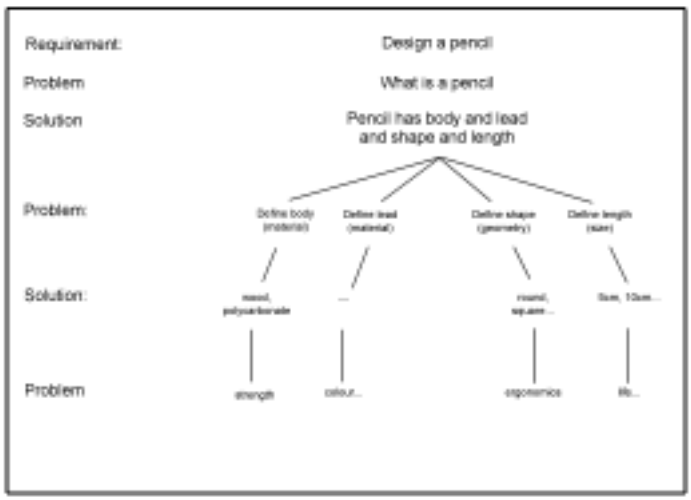

Fig. 1. The design of a pencil problem

The information resource can be looked at in any order and for however long the student may wish; in other words, there is no prescribed route through it. This approach mirrors the real-world method of investigation and promotes traditional academic method. This resource was carefully chosen to contain more information than is needed to ensure a serial search will not reveal the solution. The student can get

help from the database in the form of Hints. Each hint appears in both spoken and textual forms. The voice of the tutor is recorded for the spoken form to strengthen the bond between student and tutor and to reduce feelings of student isolation. Hints can be of two types: Hints say what the next step is while Big Hints give part of the problem solution. More marks are deducted for the latter than the former although once a particular hint is chosen the student can listen to it repeatedly without further penalty.

The assessment is in three parts: a solution mark (from the solution questionnaire), a hint mark (deducted) and a strategy mark (how the student used the database). For individual student performance analysis the tutor receives for each student a profile giving details of their marks, search strategy, hint usage and questionnaire answers.

Description of a typical student session with MTutor

Information screen

Logging on to MTutor the student is presented with an Information Screen. This describes what they may expect using MTutor, how they use the system and advice on how they should approach problem solving.
They are encouraged to look at the database before starting the problem to familiarise themselves with how to navigate it. The hints are not visible at this stage and the activity is not tracked.

Fig. 2 The Sound Level Meter Problem

The Problem

When the student is ready to start they select the Problem button in the lower right-hand frame of the screen.

This initiates the tutorial session. It calls up the Problem specification (Fig.2), turns on the activity tracking and shows the hints where appropriate.

The electronic engineering tutorial requires the student to design an audio sound level meter. It is intended for third year undergraduate students and should take approximately 1.5 hours to complete. It was chosen to be sufficiently challenging yet achievable across the ability range. The specification is deliberately ill-defined to reflect specifications they are likely to meet in the real world. It is left to the student to identify these deficiencies and to formulate their own ideas on how to resolve them. The specification gives details not only on the device that the student is required to design but also on what they are expected to do in this particular tutorial e.g. producing their design on paper.

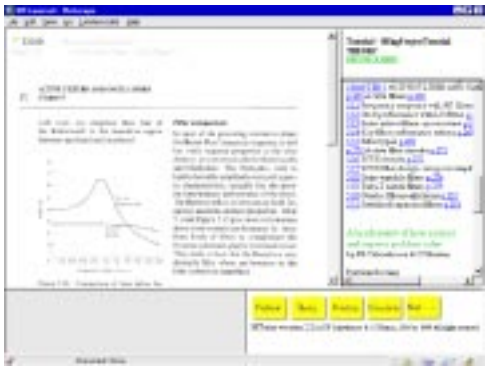

Fig. 3 A Theory information card

Browsing

Here the student devises their solution on paper using the database for the information they require. The electronic engineering tutorial has approximately 200 database cards of information representing in the region of 9.5 hours reading. A 'card' is taken from MTutor's first manifestation in HyperCard and is a self-contained, screen-manageable unit of information on a particular topic. The student can get help in the form of Hints. An example of Hint buttons can be seen at the top left-hand side of the screen in Fig. 2. On selection, the hint is revealed as seen in the bottom left-hand frame of the screen.

Each card is categorised as either Theory or Practice and is accessed from the corresponding Browser (Figs.3 and 4). These Browsers are selected from the button bar on the bottom right of the screen.

Each Browser lists approximately 100 cards grouped into categories. The grouping is an aid to searching and not a suggested order of

examination.

The right-hand side of each Browser has location buttons which provide quick and easy access to the corresponding categories. Alternatively, the student can just scroll up and down the screen. A card is simply selected by clicking on it with the mouse.

Fig.4 An example Practice information card

During the development of the original HyperCard system,[7] several Browser designs were evaluated for ease of use and navigation around large information sets. The chosen format employs a multilevel hierarchical index structure, which is presented as a vertically scrolling window. Three methods of navigating this index are provided.

Theory cards (Fig. 3) hold information on the problem background theory, related electronics theory and general electronics theory. The Practice cards (Fig. 4) give details of the application domains and solution building blocks. On completing the problem solution the student selects the NEXT→ button in the bottom right-hand corner of each Browser which then takes them to the Solution Questionnaire.

Solution Questionnaire

The student's paper solution is described to the system via a set of carefully chosen multiple choice questions in the Solution Questionnaire. These searching questions probe deeply into the solution and give a clear picture of the design. In the case of the audio sound level meter tutorial there are seven questions interrogating aspects such as the nature of their solutions, their operational limitations and the identification of any missing information from the problem specification. They are a mixture of check boxes and radio buttons and the form is examined on submission to make sure that a sensible number of options has been chosen. Marks are allocated to the responses and these recorded as part of the monitoring for a particular student.

Marks

On completion of the Solution Questionnaire the students receive their results as seen in Fig.5. The final mark has three constituent parts: the Solution Mark, the Hint Mark, which is deducted, and the Strategy Mark. The Solution Mark is the mark given for the quality of the solution and is obtained from the Solution Questionnaire. It has a maximum of 70 marks. Hints incur mark penalties: 2 for a Hint and 10 for a Big Hint to a maximum of 30 marks. This means that if a student does a perfect problem solution with 70 marks but has used Hints incurring the maximum penalty, the highest mark they can get is 40 - a basic pass. The Strategy Mark is the mark awarded for how the student arrived at the solution and has a maximum of 30. It is derived from the tracking of the cards viewed in the database and is an attempt to measure the 'expertness' of the problem-solving strategy, given, as previously described that experts problem solve using a top-down, breadth-first approach. To achieve this each card is allocated a level from 1 to 5 corresponding to the expected levels of progress through problem solving when using such an approach; from the Problem Specification at level 1 through to the cost of equipment at level 5. The card trace records which card is viewed, the time the card is called (as the time elapsed from the start of the session) and its level.

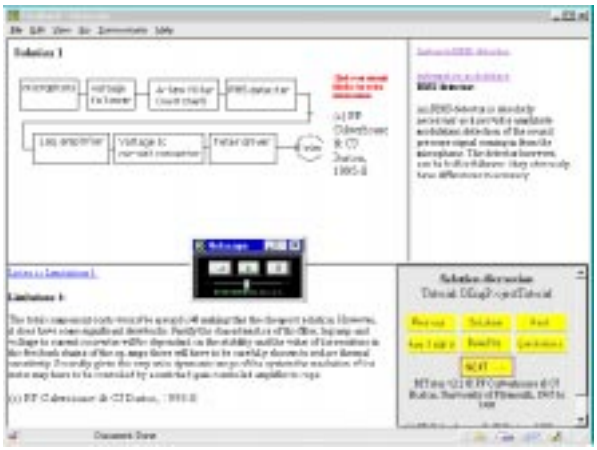

Fig. 5 Screen snapshot of an example solution

A top-down, breadth-first approach would get a positive linear regression using a least

squares method line through the time/level set of data points. To overcome distortions in the linear regression due to differing lengths of time taken to complete the tutorial, the data points have been normalised to fit a 60-minute session for strategy analysis.

Solution Discussion

The tutor presents a selection of valid solutions to the problem each showing key features worthy of note. In the audio sound level meter tutorial four block diagram solutions are examined. The student can choose to hear and/or read the tutors views on each solution including any areas of difficulty and how the solution was arrived at using the database. The student can select to view the relevant cards in the database to follow through the argument. In this example the student may also click on any part of the diagram to hear and/or read why that particular component was used (Fig.5).

Evaluation

Evaluation of the learning experience is important. It offers benefits to both the student (reflection, voice) and to the tutor (how received, possible improvement to process). To these ends there is an Evaluation Questionnaire asking for the student's views on using MTutor. The results of this are stored in the student profile record.

Discussion Group

One of the benefits of the traditional tutorial is that students have the opportunity to discuss the problem with the tutor and their peers. The MTutor Discussion Group offers a similar forum to students who have completed a tutorial. On selection of the topic, the student can read the other entries, contribute to the existing discussions or put forward their own comments and questions. The tutor may follow the discussions for any responses they can contribute.

The MTutor system is required to be secure, to track student usage, present and analyse questionnaires, and control access to the discussion groups. MTutor uses a database on a web server to hold all the tutorial information and the tracking of student activity. The whole system is managed using web cgi scripting with Visual Basic programming.

Evaluation

The authors have studied 21 professional and student engineers solving a conceptual design problem using a development version of MTutor[8]. These studies highlighted the differences in expert and novice problem-solving strategies. Further studies with MTutor using 24 student subjects confirmed the simplicity of the database browser navigation method, the great value of the solution discussions and the general acceptance of the automatically awarded mark. This laboratory study also revealed that only 1 student of 24 required additional direct tutor contact to clarify the problem, its solutions and the techniques used to solve the problem. In addition only 1 student of the 24 found the interaction for a two-hour period with the computer TV display screen to be arduous.

Over 145 evaluation questionnaires have been analysed to date, with the majority signalling significant positive responses from users to the principle features of MTutor and to the value of the tutorials. The solution discussion was felt by many to be of great value, as indicated by the comment of the student who recently took a MTutor tutorial: 'an excellent and totally different approach to solving a problem. I would like to try different problems to improve my design method'.

Discussion

MTutor offers a number of benefits to both staff and students. It also has some drawbacks. These will be dealt with in turn.

Staff benefits

MTutor takes pressure off staff by providing computer-mediated tutorials. It teaches approaches to problem solving without staff involvement. It reduces the numbers of students seeking the tutor for assistance. MTutor also encourages self-supported learning in students. It has strength in formative assessment. It may be used with any level of ability. The system has been designed to be extendible, so that once a database and a tutorial problem have been developed, it is a simple matter to add more tutorial problems. It is quicker to develop computer-based learning sessions than when using traditional authoring tools. Tutors can participate in the post-tutorial discussion groups.

Drawbacks to staff

When holding small group tutorials tutors can reduce their preparation burden by holding highly interactive tutorials, which rely on the tutor's skill in pressing students for concepts and solutions. In these situations staff do not have to have detailed solutions to hand, as they can rely on members of the tutorial group to voice these solutions. However MTutor replaces the tutorial, so the preparation must

be more detailed. In particular the solution discussion may be time consuming to complete in comparison to a normal tutorial, due in part to the need to make detailed public statements of solutions that could cause hot debate with one's colleagues. This debate can be defused by involving peers in the preparation of the solution session.

Student benefits

Self paced learning. The tutor is effectively on-hand through the tutorial hints and in the solution discussion (via the spoken word of the tutor). Information is on-line, so a student does not have to spend hours looking or waiting for books. Problem solutions which define the expected outcomes are also on-line for immediate post-problem analysis (feedback is most beneficial when the problem is still fresh in the mind and there is no waiting to speak to the tutor). There is no peer pressure. Immediate feedback on the user's performance is available. Solutions are immediately available. Participation in the post-tutorial discussion groups allows students to debate with their peers and their tutors. All students get the same treatment, that is the same tutorial, the same external information base (as against their own internalised knowledge), the same hints and the same tutorial-solution feedback. This consistency is important.

Drawbacks to students

There is less physical contact with tutors. There is no personalised help.

Conclusions

A system has been developed that encourages students to think for themselves and to support them through their problem-solving activity. It also provides solution(s) as immediate feedback to close the learning loop. A discussion group supports the student post-problem. The system replicates most of the functions of the traditional tutorial. It does so with a standard set of answers so the final student experience is constant across the cohort. The tutor is represented through their hints and solutions. These appear in text and spoken words during the tutorial.

MTutor makes no attempt to determine the mismatch between required and actual performance but requires students to use their own reasoning skills to determine their own shortcomings. This is much more akin to a normal work environment.

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Two models of virtual learning environments for university staff & students

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In higher education we are all familiar with the constant push towards increasing student numbers, widening access and student-centred learning. External and internal pressures encourage us to embrace the power of technology to facilitate these aims. While the possibilities are exciting, they are at the same time daunting, as university teachers attempt to adapt their tried and tested teaching techniques to accommodate the new media. New lecturers must now consider from an early stage in their careers how they can harness computer-based tools to enhance their portfolio of teaching skills, and it is equally important for existing lecturers to keep up to date with developments in learning technology. Staff developers must also rise to the challenge and meet this demand by providing opportunities for lecturers to experience for themselves the 'thrills and spills' of learning and teaching in this often unfamiliar environment.

Glasgow Caledonian University's Learning and Teaching Strategy highlights learning technology as a key area, and this in turn has to be communicated to teaching staff. We have attempted to approach this in several ways and at different levels: by restructuring the 'Introductory Course in Learning and Teaching' around a web-based framework; by instigating a programme of learning technology staff workshops in collaboration with colleagues at the University of Strathclyde; by showcasing examples of individual and departmental good practice via an annual Innovative Teaching Event; and by working with individual members of staff on the integration and evaluation of technology assisted teaching and learning. The emphasis throughout does not focus on the technology *per se*, but rather on the pedagogical models technology can support. We will look here at two of the models which we are currently piloting in the institution.

Model 1: Introductory Course for Learning and Teaching

We decided to take a fresh look at the existing provision for new lecturers and attempt to incorporate an example of technology assisted teaching and learning as an introduction to what could be achieved. We aimed to provide them with a model which they could easily adapt to their own teaching, and which would also allow them to experience learning technology from a student's perspective.

The existing Introductory Course for Learning and Teaching consisted of a three day face-to-face tutorial, but it was already clear that this approach was not working effectively as there were problems with attendance, motivation and completion. We decided therefore to develop a web-based framework for resources and communication which would increase the flexibility of the course and which would satisfy the aim of providing a transferable pedagogical model of technology assisted teaching and learning.

In the academic year 1997/98 the course was restructured to take place over one semester and a variety of work-based activities included which new lecturers could fit around their particular balance of lectures, small group teaching and assessment responsibilities. In order to tie in more closely with the University's existing postgraduate certificate in Tertiary Level Teaching Methods (TLTM), an element of assessment was introduced for the first time which would provide partial exemption from certain of the TLTM modules.

To meet the aims of this restructured Introductory Course, we decided to adopt a mixed-media approach:

- three half-day face-to-face tutorials were scheduled over the semester
- study guides were provided via the course web site
- work-based activities were designed around the study guides
- participants are asked to submit 'action plans' for the course
- online personal portfolios provided a guide to progress
- computer-mediated discussion encouraged the sharing of experiences

The course web site was designed to give a cohesive structure to these elements, and to provide an easy access route to all information about the course. The study guides contain structured readings and links to further references, and incorporate work-based activities relating to the topics. On completion

of the activities participants are invited to post their self-assessments via web-based forms to personal portfolios, which consist of a series of private web pages accessible only to the participant and the course tutors. These portfolios build up to provide a record of progress, not only through the course, but also through the early stages of the participant's continuing professional development.

Computer-mediated communication and web-assisted assessment

Through adopting a constructivist approach as described for example by Mayes (1997), we hoped to foster reflection and collaborative discussion among participants. In this way, they would be encouraged to reflect not only on their own approach to teaching, but also on their students' approach to learning. With a reduction in the schedule for actual face-to-face tutorial time on the restructured course, this would be supported through computer-mediated communication.

We are fortunate in the West of Scotland to have the Clyde Virtual University (CVU), a SHEFC-funded, collaborative project with the University of Strathclyde as lead site, which provides an infrastructure for web-based teaching and learning. In order to raise awareness of this facility among participants on the Introductory Course, we decided to make use of the online discussion and assessment tools which CVU offers. Although embedded into our own course web site, the HyperNews forum is hosted for us by CVU, and participants are encouraged to use it to explore ideas and share experiences with each other.

CVU also provides a web-based assessment engine which allows academic staff to create simple online tests and quizzes for their students with the minimum of technical expertise. We have also exploited this with a simple University quiz which demonstrates the different question types available and which provides a basic introduction to the potential of computer-assisted assessment.

Evaluation

After one full year, we are now in a position to look back and take stock of the effectiveness of the restructured Introductory Course.
Although an online feedback form is provided, numbers on the course are relatively small (usually from 10 - 15) therefore evaluation so far has tended to be qualitative rather than quantitative. Nevertheless results so far have been encouraging.
The reduction in face-to-face tutorial time made possible by the flexibility of the web has been welcomed, although it is clear that the face-to-face sessions are still seen as an opportunity to 'really' get to know colleagues as opposed to 'virtually'. One participant commented, "It is better hearing people discuss their experiences... You can also ask them questions to clarify certain points or ask how their experiences might relate to your own problems".

The online portfolios have had variable usage, with some participants posting long reflective self-assessments of their activities, and others using them merely as a kind of online diary of progress. Likewise, the discussion forum was embraced with enthusiasm at the start of the course, but contributions tended to tail off over the semester. This is a well-documented problem with CMC (e.g. Harasim et al, 1996) and is an area which we are attempting to address by examining how its use can be more focused and relevant to the course topics. Although it is too early yet to gauge the longer term effects on participants' teaching techniques, we found it interesting that in spite of a low level of activity on the course forum, several saw benefits for their own students and are making use of CVU HyperNews groups to facilitate dialogue in their own teaching. It would appear that exposure to the model therefore, is indeed influencing practice. A more detailed description of this model can be found in Drysdale & Creanor (1998).

Staff development in learning technology

Another strand in the staff development strategy for promoting applications of learning technology is a series of one-day workshops offered in collaboration with colleagues in the University of Strathclyde. The workshops on offer cover the areas of choosing the right technology, web-based teaching, computer-assisted assessment and internet communications. This last workshop, in particular, offers participants opportunities to explore different aspects of internet communication in the context of learning and teaching in higher education. During the course of the day participants at GCU hear talks by three guest speakers from different departments within the university about their uses of internet communications with their students. Participants also gain hands-on experience of using internet communications in a series of live link-ups with participants at the University of

Strathclyde. The applications used are:

- Microsoft NetMeeting for desktop videoconferencing, synchronous chat and whiteboarding;
- Netscape Conference for audioconferencing, synchronous chat, whiteboarding, shared web browsing and file transfer;
- HyperNews for an asynchronous discussion group hosted on the CVU server
- a videoconferenced debate on the Metropolitan Area Network (MAN) where the high bandwidth gives near broadcast quality video and audio transmission.

At the end of the debate a vote is taken on whether or not internet communications have the potential to enhance learning and teaching in higher education. On balance, the vote is usually in favour of the motion. Interestingly, the last time the course was offered those voting against the motion were all physicists, chemists or engineers who perceived only difficulties in applying the technology within their own disciplines.

Throughout the day staff responses to the various aspects of internet communication are mixed. HyperNews is almost invariably the best-received element of the course, perhaps because of its resemblance to using an email mailing list. Several staff have, on completion of the workshop, contacted the CVU Registrar with a view to establishing one or more discussion groups for their own students. Next most popular is usually CVU where staff can see how it could be used in their own teaching, either as learning support or distance learning. The least preferred aspect is desktop videoconferencing. Staff have difficulty seeing the usefulness of a medium where the quality of both video and audio channels is perceived to be so poor, although experience elsewhere eg in the University of the Highlands and Islands (UHI) project indicates that poor technical quality is not, in itself, a barrier to learning.

Model 2: Virtual enterprise in engineering

One of the guest speakers at the workshop is a member of the Department of Engineering where communication and information technology (C&IT) is increasingly being used to support student learning in the context of a virtual enterprise which comprises quite detailed information on the company including the organisation's structure, marketing, finance, manufacturing and design. The virtual enterprise is a vehicle whereby students experience the 'real' activities needed to develop products, where they recognise the parts played by all functions in the company by requiring them to consider the many different facets to product development (Falkang et al 1998). Communication and teamwork are key elements of the students' learning experiences.

This form of group project has been used for several years within GCU and also between GCU and Sheffield Hallam University. There are three types of student group: full-time students working in-house; part-time students; and full-time students working with students in another university. Each type has characteristic communication needs:

- Full-time students working in-house experience little need for C&IT within their groups and use the media only to communicate with their tutors.
- Part-time students attend university for only one day per week and rely on email, fax and telephone for the majority of their project. Despite this, the additional maturity and industrial experience of these students enables them to overcome the communication barriers with little difficulty.
- Full-time students working with students from another university perceive a need to make conventional 'eyeball' contact with students at the remote site. In the early years of working with students from Sheffield Hallam University face-to-face meetings were organised at the start of the project, but this involved travel and added significantly to the cost and administrative burden for staff organising the project. In subsequent years students have had to rely on telephone, fax and email for communication, supplemented with a web site containing photographs of the members of each group. Students reported all sorts of communication problems including the difficulties of communicating with strangers, the inadequacy of one-to-one telephone conversations in group project work and technical difficulties with email (Bramhall et al, 1998). In 1998 videoconferencing was introduced in an attempt to provide a solution without the need to travel, a move which was enthusiastically received by the students themselves (Drysdale et al, 1998). Students appeared unconcerned about the technical shortcomings of the medium (ISDN2), unlike staff at the internet communication workshop.

Student feedback on the use of C&IT

Overall, the students have learned that the use of any electronic medium is not a guarantee of success. Using videoconferencing did not, in itself, seem to improve communication of ideas when measured against the information that should have passed between group members. Its use did, however, focus attention towards the capabilities of electronic techniques. There was a clear perception that videoconferencing was a medium which will gain in use and they should strive to achieve competence in using the medium, having discovered that simple, unstructured conversation was comfortable but of little practical use without an agreed plan/ agenda and a disciplined approach.

The use of email and fax, while being more familiar, was found to be flawed in so far as both techniques relied on a two-way relationship. Failure to acknowledge receipt (as a minimum action) lowered confidence in the communication medium to the extent that repeated errors of this nature could quickly lead to group dysfunctionality. Student responses suggested that email and fax were regarded as a mechanism to convey facts, but when opinions and strategy were to be discussed, the conventional channels of communication are still preferred. In practice this means face-to-face meetings and, if this is impractical, videoconferencing or telephone in that order. Note that techniques such as chat and whiteboarding have not been assessed: these are planned for 1999.

Conclusions

In this paper we have attempted to show how the Learning and Teaching Strategy's commitment to encouraging adoption and innovation in learning technology has shaped our approach to staff development for new and existing staff and to the dissemination of good practice within the university. The two models of virtual learning environments described have been developed to achieve specific outcomes which are concerned with learning skills. They can be considered to be discipline-independent.
Both of these models have featured in the University's annual Innovative Teaching Event. We hope that others will find ideas worthy of further consideration in developing their own models for virtual learning environments.

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Virtually There: Collaboration, CoMOOnity and ReTOOling text-based virtual reality

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Those familiar with synchronous, text-based communications are likely to think of bare 'chat' programs. Such applications permit synchronous exchanges to occur at any time, on any newly-created 'channel'. Users meet and communicate in text about any topic they please. Chat may remind many users of the Citizen's Band radio craze of the 1970's when users with two-way radios regularly chatted with each other about whatever topic came to mind. When contrasted with MOO, however, the limitations of bare chat become fairly obvious.

MOOs provide users (also called 'players') with powerful, programmable objects, whose use is limited only by the programming expertise of the player and her/his imagination. Visits to the rapidly-proliferating domain of 'educational' MOOs, allow the visitor to meet other users and to try dozens of useful, meaningful and purposeful tools and activities which it is impossible to create in a bare chat environment. This paper will provide a brief overview of some of the tools and activities that have been developed at Schmooze University, a MOO created specifically for ESL/EFL learners, and for those interested in cross-cultural communication. We suggest some ways in which these tools may be employed to foster collaboration and community within text-based virtual reality. These examples are related to the area we know best – language learning and teaching - but are, we believe, more widely applicable. Finally, while providing these examples, we will also touch on some of the problems which can occur in using text-based virtual reality as a forum for collaborative working, and make some recommendations based on our own experience.

Synchronous communications technologies such as MOO encourage collaboration between colleagues who would otherwise never have the opportunity to work together. Our own experiences of using MOO to collaborate and to develop collaborative, activity-based learning situations within MOO provide illustrations of the potential of this medium for providing a meaningful, purposeful and engaging learning experience which serves both to socialise and to involve the learner in the online community.

What is a MOO?

MOOs were originally developed to enhance text-based, role-playing games like Dungeons and Dragons via the Internet, but were soon adopted for other purposes including, more recently, education. A MOO is an object-oriented database housed on a remote server. The database responds in real-time to commands entered by ~~its~~ users who log in from around the world. Users can socialise or work with friends and colleagues. They can also interact with the text-based environment itself, 'moving' around by entering simple commands, as well as dynamically developing and altering its contents in real time by creating new, text-based objects or descriptions.

> *The delight of MOOs is that, not only do they allow synchronous conversation, but that they also provide the illusion of an environment in which the learners can move around, do actions and create objects*
>
> ***Turner 1996***

In terms of the exact technical details of MOO, however, we would argue, with Keenan et al (1996), that for the average user:

> *…it's probably less important to know exactly what they are and more important to understand how they're used.*

Two popular misconceptions about MOO

As a result of their origins in gaming – which is clear from the way in which users are classified as 'players' (users) or 'wizards' (administrators), many non-MOOers perceive MOO as a type of competitive, role-playing game. This is, as Marvin (1995) points out, a misperception – most MOOs do not involve the collection of points and do not require participants to 'win'

or 'lose'. There are many MOOs with a professional or educational orientation where users meet to work or to discuss topics of interest to the professional community, as well as to socialise with each other.

The second misconception about MOO is that it is, like Internet Relay Chat (IRC), a 'chat' channel. This is not the case. As we have already stated, users of MOO can interact with their environment as well as with other users. Unlike 'chat' channels, which are brought into being by the fact of users logging in, the MOO environment – objects in the form of rooms, personae and anything else users may have created - exists independently of its users, although they shape and develop it. Once a user disconnects from a 'chat' channel, that channel is gone. MOOs are always there, even if there are no users connected. Indeed:

> *The fixed descriptions of objects, rooms, and characters provide a sense of depth and permanence to the world of the MOOs, while the synchronous interactions of the participants animates the world.*
>
> ***Marvin1995***

What can you do in a MOO?

To the new user, it may appear that 'chatting' is the only activity available in MOO. The primary function of many MOOs is, indeed, games-playing or chatting but, as Bruckman (1997), Fanderclai (1995) and Bollier (1995) note, MOOs do seem to exhibit distinct community building advantages in terms of being repositories of things to *do* as opposed to the chatting function promoted by conferencing systems such as IRC. Users are able to work together to solve problems, play games or simply to interact with the environment and each other.
Educational MOOs such as Schmooze University, where we of this paper meet to collaborate, offer a range of learning activities that move well beyond chatting. For example, at Schmooze University, it is possible, among other activities, to:

- have a drink in a virtual bar…or teach the bartender to make a new drink
- order and eat food in the virtual restaurant…or teach the waiter and chef a new recipe
- eavesdrop on the conversations of other users as they dance on a virtual dance floor (after a few exchanges, the conversations are gapped in order to make eavesdropping more difficult!)
- play games such as Scrabble and Boggle – consulting online dictionaries if required
- take part in a virtual treasure hunt with clues being hidden around the campus
- navigate a virtual grammar maze
- go for a virtual swim in a virtual swimming pool.
- meet in a virtual 'traditional' classroom for more traditional training or learning activities
- take part in virtual meetings, editing sessions and discussion groups

Collaboration and Community

> *A shared space and a shared set of activities form a common point of reference, the third place, which helps to create social interaction and facilitates collaborative [language] learning…*
>
> ***Schwienhorst 1998***

Users are able to describe their appearances (real or imagined) and reveal their real life genders, or use a neutral pronoun system to maintain convincingly gender-free personae. Additionally, they can build and decorate their own virtual space, or 'room'. While each virtual character and space has been described by its owner, almost every owner has asked other users for help in describing her/his character and creating room entry and exit messages, thus collaborating in the development of the database. Indeed, as Kolko (1998:267) remarks:

> *…even when I am alone in a room, looking at objects… I am collaborating, albeit asynchronously, with other players*

Collaboration within MOOs can, of course, take place on a much larger scale than users helping each other with character and room descriptions, but this task provides an example which fulfils the criteria outlined by Schwienhorst (1998) – users share a space and an activity which leads to social interaction as they collaborate on developing an acceptable personal and room description.

We have used Schmooze University MOO as a collaborative workspace to plan presentations and publications and to create a website which has been used in various online workshops and presentations (see below). Recently, the website has been expanded to incorporate an attempt to provide a supplemental site for learners of English who are engaged in a MOO-based project. These learners – who are based at a geographical distance from each other and

who may never have met in real life - work in groups within the MOO, experiencing a text-based representation of life on the north-east coast of England. As well as interacting with each other to negotiate roles, responsibilities and meeting times within this virtual space, learners are also provided with hotlinks which allow them to interact with web-based images, sounds, texts and tools. Eventually, these groups of learners will expand the database to create their own, collaboratively designed and developed virtual spaces with links to the Web, using the original workspace as a model (which they will develop, alter and redesign for their own purposes) or springboard for their own ideas.

Virtual spaces

> *All too frequently I log onto an educational MUD to find myself in a virtual representation of a university campus. Separate buildings highlight the traditional divisions among disciplines, and within these buildings are elaborately programmed classrooms.*
>
> ***Fanderclai 1996***

It is true to say that educational MOOs frequently provide representations of the 'traditional campus', complete with classrooms, dormitories, libraries, a students' union building, and other objects which have been designed and programmed by the users of the MOO either individually or in collaboration with each other. While we have argued elsewhere (Davies et al 1998b) that, like Fanderclai, we entertain doubts about the efficacy of transferring the real classroom to the virtual environment, we would also argue that, for some learners, the 'security' offered by this traditional representation in guiding mutual role expectations may be necessary until they have come to terms with the new environment.

What tools are available?

One feature the objects which are outlined below have in common is that online help usually provides an overview of the various commands available for use with a particular tool. It is worth reiterating that if online help does not clarify the use of the item, there are almost always users online who are willing to provide explanations.

MOOmail, mailing lists and (dynamic) FAQs

MOO offers facilities similar to e-mail services on Internet servers. MOOmail is the MOO version of traditional e-mail, but is limited to an individual MOO community. Lists within a MOO permit the user to subscribe to those lists and to receive any MOOmail sent to those lists. Similarly, the user can simply address her/his MOOmail to a particular list, and other subscribers to that list will receive that message. Schmooze University, for example, has lists for policy discussion, current events, teachers' notices, and our 'collaborative MOO project', where participating teachers are kept abreast of the latest developments in the project.

Any user can set up a list, though it is necessary to contact the MOO administrators (wizards) to request permission to make the list active. MOO lists can also be used dynamically - list owners respond to questions raised by the subscribers. Such lists can include threaded discussions or simply reply to specific questions. In the collaborative MOO project mentioned above, an unthreaded project mailing list was offered to participants as a forum for their questions. The concept behind providing this list was that participants would post their questions about technical and/or project issues there. The list would become the tool that was used to check for answers to any questions before users actually asked the questions on list, in the style of Frequently Asked Questions (FAQ) lists.

Collaborative whiteboards and blackboards

We make regular use of our own collaborative whiteboard (CW). This CW is used to keep brainstorming notes, quick, short messages, lists of participants in projects and various other information such as meeting times, useful quotations or even general greetings to the other members of the team. CWs are programmable to be writable or readable by selected users. They can be private (restricted to specific readers and writers – these groups may be identical, or the readers can include the writers and other, named users), semi-private (restricted group of writers, unrestricted readers) or public (unrestricted writers and readers). The collaborative language learning MOO project in which we have been involved makes use of private CWs for learner groups and extends the reader group to include tutors and project developers, while our own CW is totally private, being readable and writable by the owner and her collaborators only. In terms of public spaces which are available for brainstorming, Schmooze University contains a Grafitti Wall, where any user can write anything and any other users can then read this.

Virtual blackboards operate in a similar way to

the CWs described above. The Neteach discussion group, a group of language teachers which meets regularly at Schmooze University to discuss pedagogical issues, makes use of one such blackboard object in order to raise questions, air problems or simply to brainstorm during the meetings.

Books

Although similar to collaborative whiteboards, books, contain multiple 'pages' that can be written on. It is also possible to program or define who has permission to alter the contents of any book. They have the portability of whiteboards (which are, after all, portable) and can be used in any variety of imaginable ways. We, for example, use books to store bibliographic citations and important quotations from various sources in the literature of their fields of interest. Books may also be used in less 'academic' ways, such as compiling user-written Haiku or recipe collections, or providing salutations to, or personal information about other users.

Bots

Bots, short for 'Robots' are artificial 'players' in that they are programmed objects that can respond to certain commands given by 'real' users. In the MOO game, Boggle, for instance, 'Boggler' the bot will play with any user at any of three different user-requested levels of difficulty. _Boggler plays only on command, and may compete against up to five users who have joined the game. Manuel, the waiter bot in MOOrrey's, the virtual bar, responds to orders for food and drink. He is also programmed to ask users about any orders which are not in his repertoire. Iona, the virtual bartender, will do the same with unfamiliar drinks, dynamically adding them to her list of offerings, while Youssou, the DJ, adds the titles of requests to his playlist to play later.

Logging function

Using raw Telnet or a MOO client, it is possible for a player to keep a record or *log* of any MOO session in which s/he participates. Although this raises ethical issues– it is stressed to all users of Schmooze University MOO, for example, that it is unethical to keep logs of sessions without obtaining permission from all concerned - the logging function can provide a very useful record for all users, from language learners to collaborative writers, as English points out (1998). Language learners can use their MOO logs to identify and reflect on any linguistic errors they may have made, while those who use MOO for professional purposes can employ logs to record decisions made at meetings and so on. Further, because the logging function is built into the client, rather than into the MOO itself, the user does not fill up valuable 'quota' or database space with the log, thus avoiding database bloat, one of the effects against which MOO administrators are in constant conflict.

While logging does, therefore, have many advantages, there are also some serious disadvantages to this function which must be considered: firstly, logs are personal and include everything a player sees on screen. Private conversations can be logged secretly, leading to greater or lesser violations of privacy when published under the title of 'research'

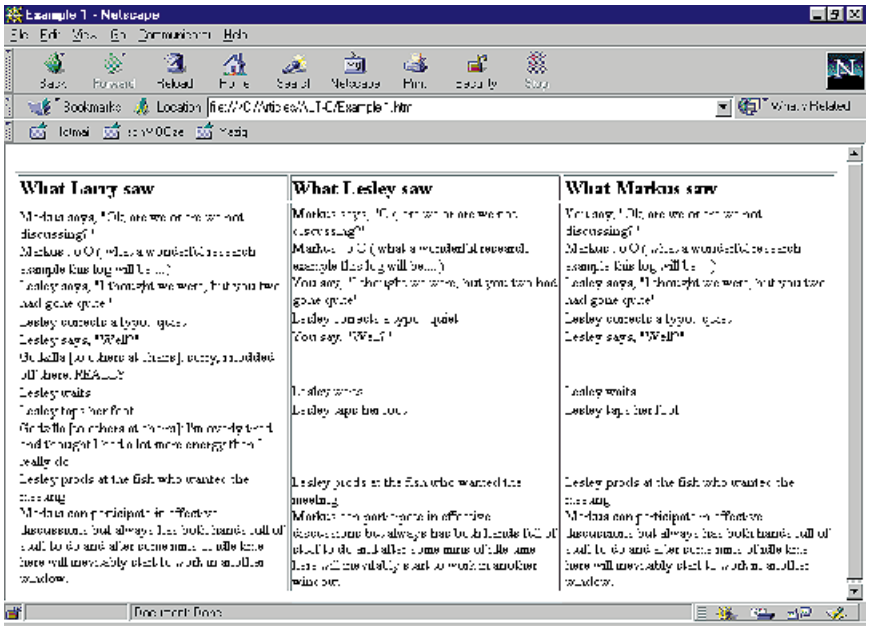

Figure 1: Different world views – an example of personalised logs.

later, without the explicit consent of all participants. In certain circumstances, logging can also facilitate violations of

intellectual property rights. If users share their MOO session logs, it may be necessary to edit out some of the content which it is not appropriate for all readers of the log, either because it is irrelevant to the discussion (system messages, for example) or of a personal or private nature.
The log one user sees is different from the log seen by another user, as illustrated in Figure 1 above.

A second disadvantage of logging MOO sessions in this way is that if a user loses the connection, any exchanges which take place while the user is disconnected are not recorded. Indeed, in certain instances, the entire MOO log can be lost as a result of a lost connection. For this reason, if logging of this sort occurs, it is recommended that more than one participant log the session. In this way, at least one log is likely to be available at the end of an online session.

Tape-recorder objects
One of the ways in which it is possible to produce 'clean logs', that is logs of MOO sessions which do not include a record of communications from users outside the group, or pages (private messages) between members of the group, is to use a 'tape-recorder' object. This object will record only what it 'sees' on the screen. Since it is an object, not a player, it does not receive a record of who logs in or out of the database, and receives no communications extraneous to the discussion. A tape-recorded log, therefore, does not need to be edited. Furthermore, because the tape-recorder is part of the MOO environment, it continues to record, even when its owner is not there, thus solving the problem of logs lost as a result of broken connections. Unfortunately, the tape-recorder log ***does*** use up database space, and so it is necessary to 'erase' the contents regularly.

We use two tape-recorders for our work at Schmooze University - Jo, who acts as Personal Assistant to the group and more recently, Viv, who is the secretary to another project in which one of us is participating. Both these tape-recorders have been anthropomorphized and look and behave like 'bots'. Jo, for example, will make and deliver, virtual cups of tea or coffee, while Viv can tell the time on request. Both Jo and Viv are able to send logs to their user-groups. Members of these groups can then send the 'tape-recorded' log directly to their own email – as opposed to MOOmail – accounts by using a single command.

Video recorders and TV objects
For processes which require a step-by-step approach, MOO offers video-recorders and TV objects. It is possible to program a sequence of events which can be played back, paused, 'rewound' and replayed by the user. At Schmooze University, as in other educational MOOs, tutorials for beginning MOO programmers are presented in this way. The user is able to select a tutorial and then 'play' it on either a video-recorder or television object. The tutorials are interactive – the user performs the actions as the tutorial explains them – with the user being able to pause and repeat the video tape at will. The output of the TV/video-recorder object may be shared by all users present in the virtual space in which is it playing, thus providing a group learning experience and allowing users to discuss together sections which they may not have understood. In this way, learners can take collective responsibility for their learning if they wish to do so.

Overhead Projectors
The overhead projector [OHP] tool allows a presentation format to be adopted. If one player wishes to present pre-prepared material to others, as in a meeting or tutorial, for example, s/he can use the OHP to 'project' virtual transparencies to the screen. All users then see the same information at the same time. In some ways, this is a rather more sophisticated version of the *@paste* MOO command which allows the user to copy and paste text-based information from any other electronic source to users in the same virtual space, or even in other virtual spaces within the MOO. Unlike @paste, however, the OHP allows the user to pre-prepare and format material for public presentations.

Classroom/meeting room
For those who take a pedagogically more traditional points of view, MOO offers the tailor-made virtual classroom or meeting room, complete with discussion areas for small group meetings, an OHP for presenting material to the entire group, and of course, a whiteboard or blackboard which the 'teacher' – and others with the appropriate permissions - can write on. At Schmooze University, several teachers bring their real-life students into this virtual world for real-time discussion either between themselves or with other, remotely-located groups. It is important to note that the discussion areas in this type of 'room' object are programmed so that the users in the 'private' areas cannot communicate with those in the 'public' areas – and vice versa - by using the usual *say* command. This is a useful

pedagogical feature, since it means that learners can work in the same room, undisturbed by others but there are also disadvantages. In Figure 1 above, for example, the log is taken from a meeting in such a 'room'. *Godzilla* was in a 'private' area, whilst *Markus* and *Lesley* were in a public area. Although all three participants were experienced MOO users, they had forgotten about the features of this type of 'room' object and, as the discussion progressed, became increasingly frustrated because those in the public area were not getting responses from *Godzilla* in the private area, while *Godzilla* could not understand why *Lesley* and *Markus* appeared to be completely ignoring his contributions to the discussion. Eventually, all three participants realised what had happened, and the logs of the session contributed to an online presentation at Schmooze University about possible sources of miscommunication in text-based virtual reality. (Davies et al. 1997) It is important to remember, then, that for the less experienced user or learner, such an occurrence could, if not clearly explained, be extremely demotivating.

Conclusion

This paper has provided an overview of some of the many tools available to the user within MOO, concentrating upon their educational uses and drawing upon our own experiences of using MOO for pedagogical and professional purposes. We do not advocate MOOs, or any other technological innovation, as a panacea for the myriad problems of the (language learning) classroom. We do, however, believe that MOOs offer a dynamically and structurally sound advance in the pedagogical possibilities of introducing autonomous (language) learners into a proactive community of co-learners comprising students and tutors. The available MOO tools and activities foster interaction, mutual help across the traditional role limitations of 'teacher' and 'student', co-construction, and collaboration in the context of a purposeful, meaningful and engaging community of co-learners who find themselves at the frontier of a virtual revolution on the teaching-learning continuum.

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Summary of the Report of the CTI/TLTSN Review Group

The Review Group of the Computers in Teaching Initiative (CTI) and the Teaching and Learning Technology Support Network (TLTSN) has produced a draft report of its findings.

The Review was established by the four UK Higher Education funding bodies in November 1997 with three aims:

- to determine how far the CTI and TLTSN had fulfilled their terms of reference;
- to capture some of the lessons learned during the lifetime of these two initiatives;
- to make recommendations on the future of these programmes at the end of their current funding period (July 1999).

This summary concentrates on the findings which relate particularly to the CTI Centres and the CTI Support Service.

Aim 1: terms of reference

The Atkins Report found that:
'The CTI has fulfilled its terms of reference and in the eyes of its direct users has provided a good and valued service. There is no doubt that its subject orientation is the source of its strength and success.'
The Report breaks down the roles and objectives of the CTI Centres as follows:

- being an information point;
- giving advice on implementing ICT in teaching and learning;
- providing a link between old and new technologies;
- enabling change in the teaching/learning of their subject.

The last of these was the role most frequently endorsed by end users. The Report pointed out that the balance between these roles differed depending on the maturity of ICT use in the various disciplines, but that there had been a clear historical trend 'away from rather simple awareness-raising twards the more complex issues of integration and implementation of ICT'.

Evidence collected by the Review Group showed that users of the CTI Centres were 'consistently pleased with the quality of service they had received', with over 88 per cent describing it as good or excellent. The Review concluded that users value their CTI Centres 'principally for the up-to-date information obtained, and for the opportunity [at workshops and departmental visits] to gain hands-on experience of computer-based learning materials and ICT-based appropaches to teaching'. Over half of all users had made changes to their teaching as a direct result of contact with the CTI.

Looking to the future, the Review found 'there was no doubt that users wanted some form of CTI to continue'. To fulfil the same or similar terms of reference, any future programme would need to build on the strengths of the existing initiative, that is to:

- be proactive;
- focus pragmatically on implementation and integration;
- have a subject specific identity.

Aim 2: lessons learned

As a broader agenda, the Review Group were agreed that 'CAL and ICT were being seen as part of an essential set of tools to be used by all staff with responsibility for mainstream learning... [and consequently] that all academic staff now needed to be IT literate'.

The majority of HEIs were found to be moving towards a teaching and learning strategy which explicitly incorporated CAL and ICT. Perceived benefits of incorporating new technologies into teaching included greater access to and flexibility of study, and the extension of opportunities for distance, collaborative and networked learning. Students with ICT skills and a familiarity with the World Wide Web were seen to be more employable and where ICT was used in the daily work of professionals in a particular field this had been a strong driver for the incorporation of CAL and ICT into teaching at tertiary level.

On the other hand 'it was also clear to the Review Group that under-utilisation of CAL and ICT remained a continuing, major problem for virtually all higher education institutions', and 'only a handful' of responding HEIs had actually implemented a teaching and learning programme of any kind. Many respondents felt the assumption that educational technology produced enhanced learning had yet to be proved, and indeed both CTI and TLTSN regarded the lack of applied research in this area as 'a barrier to the credibility of their work'. The vast majority did not expect the use of CAL or ICT to result in efficiency gains or economies.

Collaborative work among institutions was seen as the only realistic way to off-set the high development costs of technology-related learning materials. Barriers to the greater use of CAL and ICT were summarised as 'money, materials and mindset'. Specific issues identified by the Review group included:

- the lack of relevant, adaptable and high quality courseware;
- the need for lecturers to be trained in ICT skills specifically for teaching and learning, e.g. in the use of authoring tools to enable the delivery of their own materials via the new media;
- research into the effectiveness of different uses of ICT;
- the lack of incentives for collaboration;
- the need for ICT enthusiasts and champions among senior and middle management;
- the absence of rewards and incentives for innovative teaching;
- the lack of recognition for CAL development and research.

Levers to fuller use of CAL and ICT were summarised as staffing, strategies and standards. Again, a number of specific issues were identified,

including:
- staff development targeted at 'implementation within subjects rather than limited it to basic, generic skills';
- effective institutional strategies combining ICT with a commitment to the enhancement of teaching and learning;
- adequate resources for staff development and support, and for the purchase of specialised software and learning materials;
- networks for the sharing of good practice and up-to-date information;
- demonstrator projects, case studies and consortia for the development of materials;
- moves towards 'an agreed common specification for the development, use and management of an ICT learning environment'.

The vast majority of respondents in all parts of the study saw the need for a continuing, long-term resource, external to institutions and funded by top-slicing. This would offer information, advice and expertise of two distinct kinds:
- subject-specific support in the implementation of new technologies and the development of new materials (as per the current CTI remit);
- advice on generic new technologies (as per the current TLTSN remit).

Aim 3: recommendations for the future

The first recommendation of the Review Group is the rationalisation of initiatives supporting academic staff in the use of ICT. The current situation has led to a duplication of effort, the potential for competition among rather than cooperation between initiatives with similar remits, and coordination structures which have developed according to historical exigency and so work 'on the wrong axes' to support users effectively. The Review Group therefore recommends that a standing committee of the four funding bodies be established to achieve strategic cooperation across the UK.

Criteria for rationalisation must focus on the needs of the real end-users. 'This means retention of a subject focus but one that goes beyond ICT to be comprehensive and inclusive of good practice sector wide.'

The Review Group therefore recommends that CTI and TLTSN should not continue in their present form beyond the end of the current funding period (July 1999). Instead of the current network of CTI Centres, there should be established 'a new broad-based programme of subject centres as comprehensive one-stop shops and information gateways'. The exact make-up of the subject centres will not be finalised until after consultation, but the intention is that all subject areas will be covered on a UK-wide basis.

Centres will be hosted by individual institutions of higher education, as are the current CTI Centres, to ensure that staff remain in daily contact with academics in their subject area. Each centre will be awarded to one host institution on the basis of a competitive bid, and will then have responsibility to support teaching and learning in that subject area throughout the UK. Centre staff will work closely with relevant discipline networks, subject associations, and professional bodies.

Complementing this subject-specific network, there should be established 'a single generic technology centre on a UK-wide basis'. The technology centre and network of subject centres will all be managed by a single Central Unit under a Director.

The timescale and details for implementing the recommendations of the Review Group remain subject to the results of a consultation process in which the CTI will be centrally involved. Further information will be published on the CTI central Web site as soon as it is available.

Appendix A: the Review Group

The composition, terms of reference and method of working of the CTI/TLTSN Review Group can be found at **http://www.hefce.ac.uk/Docs/initiat/current/reviewof.htm**.

The findings of its Report were based on: evidence given by the constituent centres and coordinating bodies of the two initiatives; surveys of users and clients; a questionnaire sent to heads of all HE institutions; visits to 14 sample institutions; a 24-hour residential meeting with representatives from different HE institutions, funding bodies and relevant organisations.

Appendix B: functions of the proposed new subject centres

Functions of the subject centres will be:

- Acting as knowledge brokers, promoting up-to-date concepts of good and innovatory practice based on evaluation and research in their subject area. Over time this should extend to European and international sources and to comprehensive coverage of pedagogy and instructional design.
- Facilitating the sharing of practical experience in the implementation and integration of innovatory and good practice.
- Managing a network of departmental users.
- Reviewing new teaching/learning materials that come onto the market and the application of new technologies in the subject context.
- Disseminating outcomes of other subject-based initiatives.

Contact Information

The Computers in Teaching Initiative Centre for Engineering (incorporating the Engineering Science Program Exchange is one of 24 subject based centres funded by HEFCE, SHEFC, HEFCW and DENI and is located at Queen Mary & Westfield College, University of London.

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