Innovations in Learning Technology

Toshio Okamoto
Graduate School of Information Systems
The University of Electro-communications
Tokyo, Japan
Tel: +81 424 43 5620
Fax: +81 424 89 6070
okamoto@ai.is.uec.ac.jp

Roger Hartley
Computer Based Learning Unit
University of Leeds
Leeds LS2 9JT United Kingdom
Tel: +44 113 233 4626
Fax: +44 113 233 4635
j.r.hartley@cbl.leeds.ac.uk

The educational potential of computer based technologies is wide-ranging. The introduction of multimedia can not only deliver interesting materials at a distance, but utilise 3D images and virtuality to enable students to explore and interact in ways which exploit visualisation and constructive modes of learning. Enabling computer based systems not only to manage student interactions, but also to interpret and support differences in learning paths and styles, allows them to accommodate more effectively a wider range of student experience and preferences. Wide area networks and the Internet stimulate a sharing of materials and collaborative learning methods between students and teachers that can be interactive and build up a social awareness that can span cultural differences.

These are some of the educational opportunities provided by the new technologies, but ensuring they are accessible and understood by teachers in ways which stimulate the introduction of innovative pedagogies is not easy, particularly at a time of increasing financial and managerial accountability, greater teaching commitments, and where assessment methods still seem to follow conventional approaches. Hence the provision of software tools and materials which support innovation in teaching/learning, which enable the re-use of materials in adaptive ways, is important. Also, good examples of innovative practices that can serve as models are necessary to move pedagogies forward in ways that carry authority and give some assurance of educational benefits. Hopefully the eleven papers that form this Special Issue, and which are developments of papers presented at the ICALT-2001 Conference held at the University of Wisconsin, Madison, will achieve some of these objectives.

In the first paper Bouras et al describe the methods, tools and stages of development of a system architecture for Intelligent Virtual Training environments. The development process is iterative, uses rapid prototyping as it moves user requirements to a functional specification of system features that employ UML notations. Their architecture (the INVITE system) incorporates multi-user 3D features to support group learning and photo-realistic avatars of participants for better “self-creation” in collaborative learning situations.

In their research, Sampson and Karagiannidis address the need for the efficient and effective redistribution and re-usability of electronically published (web-based) content that can be used adaptively with different learners. The work focuses on the European “Knowledge on Demand” project and includes a concept ontology of learning materials, and competencies which relate to the roles of this ontology. This guides the definition of appropriate learning resources, with different user profiles and navigation rules governing the matching of profiles to these resources, and assessment items directed at the specific competencies of users. The architecture and a prototype system is described with illustrations indicating how the system facilitates personalised access and management of the learning materials.

In designing these types of learning environments, Klett concentrates on principles governing effective visualisation and visual communication. The paper is widely referenced in its reviews, and important features related to these aspects are motivation, memorising, form and structure, and explanation. These are incorporated into the design and composition in interactive tasks, and linked to improvements in the navigation of the learning content. This leads to a discussion on how cognitive, structural and layout considerations can be mapped onto the learning interface to allow access to information and illustration at various depths, and which seeks to achieve visual balance and visual flow in guiding and supporting the learner in these decisions.
The next papers continue this probe into cognitive processes with Albalooshi and Alkhalifa noting that animations and verbal representations can be in competition when presenting information to students. However, they discuss an architecture which combines the two into a complementary and adaptable multimedia tutoring system. Students may prefer one type of presentation over the other, and the authors test the hypothesis that if there is an interaction between the two modalities, this may “fortify” or “confuse” learning. The experimental data support the view that the two media can fortify learning irrespective of student preferences, thus reinforcing the value of such multimedia facilities as a cognitive tool.

Kort and Reilly move the debate towards the interplay between emotions and learning, which they maintain is more complex than previous learning theories have acknowledged. Moving to a model which supports the construction of knowledge and the development of insights allied to personal value system, they identify six emotion axes that arise and are relevant to learning. These are then linked to the cognitive dynamics of the learning process on a four-quadrant model partitioned by Constructive/Unlearning and Positive/Negative Affect dimensions, and extended on a cumulative knowledge axis. The authors claim their model goes beyond previous research not only in the range of emotions addressed, but in their formalisation of the dynamics of learners’ emotional states in a language that supports metacognitive analysis.

Accommodating individual differences among learners continually attracts the interest of researchers, particularly as larger networks of students are becoming established. Carchiolo et al. have proposed and implemented a method of creating an adaptive web-based environment that decides on learning paths, dynamically modified, that take account of student needs and capabilities. The system also allows the exploitation of collaborative learning tools. The model takes account of both teacher and student viewpoints, the former adjusting the course to the class and the latter expressing individual requirements for traversing the domain learning materials in terms of time availability, the learning media, learning style preferences, and desired levels of difficulty. The architecture of the prototype system is described, and features of course management, monitoring, exercises and tests, and collaborative learning are illustrated. Some open issues remain for discussion, eg. granularity and levels of abstraction in course unit descriptions, methods of extending student profile information, defining an XML-based description language for educational materials, and the exploitation of feedback to improve system behaviour.

Many learning domains are complex in dealing with problem situations that involve interrelated components which are subject to changes over time, and often show ill-defined effects. In these situations, where shared knowledge and interactions can be a useful asset, collaborative learning assumes a new importance. Milrad proposes that the use of construction kits and modelling tools operating under “Model Facilitated Learning” can accommodate these objectives by providing multiple representations which augment the cognitive and social processes of scientific understanding and learning. A class project in “Computers and Learning” is used for illustration incorporating a variety of model building and simulation tools. The pedagogy covers phases of problem-orientation, inquiry-exploration and policy-development. Student reaction was positive, and gave opportunities for reflection on the learning process.

The paper by Chong et al. considers the ways in which pre-recorded lectures can maintain interactivity with the audience by the speaker dynamically controlling the video to add clarification and explanation. The authors propose text-to-speech synthesis as an alternative or supplement to human narration, and propose Whiteboard VCR as a system which enables slide mark-ups and slide switching presented via the Web to be synchronised with a narration that can mix audio, video and speech synthesis. In this system, presentations can also be authored on the fly, captured live and edited for viewing on demand. The technical concepts and the Whiteboard VCR authoring tool are described, and the procedures for producing the presentations are clearly illustrated. An initial evaluation was undertaken in which synthesised speech (the robotic voice), the human voice and a mixture were compared in equivalent presentations to groups of English and non-native English speakers. The results showed that each type of presentation had its own merits. The authors also argue that their approach is advantageous in offering two synchronisation styles, so that users can either select a streaming or a split approach (with audio and video in one media file, and annotated slides in separate HTML documents) to deliver the content.

The next two papers are concerned with the description and the management of educational resources. Sampson et al. comment on the difficulties of retrieving content from the Web, and the advantages of employing educational metadata technologies to assist this process. Their paper describes EM*2, an educational, metadata management tool to support the editing of documents represented in XML, and to assist in searching and navigating such education resources in e-learning contexts. Under a Virtual Learning Portal scenario, in which
users are classified as Lecturers, Editors and Managers, various tasks which engage them are outlined, and a range of software tools for creating, changing, validating, and managing metadata documents are noted and their limitations described. This leads to a description of the features of the EM² (Educational Metadata Management Tool) and the facilities it offers. These are well described and illustrated, as are the system requirements for its use.

In their paper, Lin et al propose using a Workflow Technology Model to manage flexible e-learning services. Their system called Flex-eL concentrates on process (capturing activities and their dependencies involved in the teaching/learning tasks) organisation (the participants, e.g. students and teachers, and their roles in relation to the allocated tasks) and infrastructure (the information networks and materials to be utilised in the educational tasks). Under this framework, specific objectives were set down and Flex-eL designed to support pathways through modules that relate to the learning objectives. In this scheme, courses can be designed so that modules can be performed in parallel, or sequentially, with the activities monitored and guided with each student learning at their own pace. Students complete their course when all assignments have been completed and there are various process templates available which define the order of course activities and the assessment schedules. Also, the tutor can provide advice for the student and information is available from other students so this encourages collaboration on this decision making. Progress is illustrated using graphical techniques that display the workflow and state of each activity on the Web interface. The system has been successfully employed in a postgraduate Information Technology program at the University of Queensland.

The final paper by Okamoto et al concerns the training of teachers in response to the new technologies, and notes that a new teachers’ education framework is necessary. The distance educational system RAPSODY is proposed to assist schoolteachers to learn subject content, teaching methods and evaluation techniques via an Internet-based self-training system. RAPSODY is based on an Ecological Metaphor and incorporates both designers (who describe each value of a Learning Object) and authors (who produce course materials within their local servers). Various types of learning environments are supported and a key concept is the CELL which generates the training scenario, including needs/goals, the learning flow of materials and guidelines for self-study. A Guide-Script description language similar to HTML is used by the system to interpret documents and hence control the interaction between user and system. This system is described in detail, and an initial application was undertaken in cooperation with University and Industry that used several distance sites in the training experiment. A further aim is to build rich databases by accumulating various kinds of teaching expertise.