Multi-modal learning: a case study

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Swinburne University of Technology has committed itself to a planned and structured approach to the utilisation of technology through its "multi-modal learning" program. Multi-modal learning simply means using many ways to learn. Multi-modal learning promotes the use of new media and methods designed to capitalise on the benefits offered by communication and computer technology. These benefits are added to traditional lectures, tutorials and textbooks to offer a variety of learning methods to achieve different types of learning objectives. This paper presents the outcomes of implementing a multi-modal data communications course including the use of multimedia and the Internet. The paper examines the difficulties with traditional data communications courses and then describes the MML approach to addressing a number of these problems in order to improve student learning.

Introduction

Universities today are investing much time and energy in exploring the possibilities of advancements in educational technology. Many university subjects now have components that utilise computer assisted learning, telecommunications and other technological aids. There are a number of advantages that the use of technology brings to university education that appeal to both university administration as well as lecturers on the coal face. These advantages include the perceived cost savings that university bean counters believe will be the answer to the growing participation rates and relative reduction in funding. Whilst the actual dollar savings is a debatable issue, there are real educational advantages that new technology brings to the focus of university activity - student learning. It has been established that technology such as multimedia improve the overall learning experience for a student. Marchionini (1988) states that cognitive skills are enhanced with multimedia; Tan and Nguyen (1992) believe that multimedia makes the learning process more interesting and stimulating and increases the rate of learning and knowledge retention. Gibbons (1990) argues that by enabling students to link data, information and ideas, interactive multimedia helps to make the connections which are critical to learning. "Generally, there is no doubt about the usefulness of multimedia to convey information to people" (Maurer & Scherbakov, 1995).

Different institutions have sought to introduce the use of technology in a variety of ways. Many universities have created new support units whose key purpose is to assist lecturers in their use of appropriate technology in the courses they teach. This approach relies on lecturers to actively seek funding and assistance for the development of resources for their subject area. This is a competitive and unstructured approach and generally relies on the motivations of individual lecturers.

This paper presents one university's approach to the introduction of new technology to a university course by examining in detail how one subject utilises multimedia, the Internet and other technology to maximise student learning opportunities.

Multi-modal learning

Swinburne University of Technology has committed itself to a planned and structured approach to the
utilisation of new technology in university courses. Instead of an ad hoc implementation of technology, Swinburne has adopted a total course approach through its "multi-modal learning" program. The Bachelor of Applied Science (Management Science) is a pilot program offered at Swinburne's Mooroolbark Campus in which all subjects within the course exploit the benefits of the latest in computing and communication technology. Every lecturer involved in this course is committed to trialing new methods of course delivery within a planned and funded structure.

Multi-modal learning (MML) simply means using many ways to learn. MML promotes the use of new media and methods designed to capitalise on the benefits offered by communication and computer technology. These may be added to traditional lectures, tutorials and textbooks to offer alternative learning experiences to achieve different types of learning objectives.

One unique feature of the MML Applied Science degree at the Mooroolbark Campus is the requirement that all students buy or lease a portable notebook computer with a modem. Having a computer accompany the student wherever she or he may be, has transformed teaching and learning. When the further advantage of electronic communications is added, a great step forward in flexible educational provision is made possible. Students use their laptop computers during lectures directly experimenting with statistical and programming packages. Laboratory rooms no longer need fixed computing equipment. Multi-modal laboratories simply have a number of computer network outlets which students utilise when they bring in their notebook computers.

A dial in network has been installed to allow remote access to the Campus Wide Information System and other on campus computer facilities. Students not only can access email, the World Wide Web, library catalogues and network news but can download and upload files directly relating to their course.

The MML concept encourages the use of independent learning materials to allow flexible learning. A range of resources including printed independent learning materials, computer based learning materials, videotapes and audio tapes are maintained to enable students to learn efficiently at their own pace and at times of their own choosing.

The key to the MML approach is the use of Learning Guides. Learners learn best if they are fully informed about the learning they are doing. Learning Guides are books that may be likened to learning maps. They are prepared to assist students to know what is to be learned and how to demonstrate that learning has occurred. Students use their Learning Guides to focus on what needs to be learned with what resources and allows them to take responsibility for their own progression through the course.

Multi-Modal Learning has been successful as it incorporates some of the best practices found in distance education courses along with a number of innovative approaches to traditional campus based education in a funded and planned structure. This approach has been extended to many of the courses offered on the Hawthorn Campus including the data communications course offered by the School of Computer Science and Software Engineering.

Teaching data communications

Data communications is an essential ingredient in the computer science/ information technology curriculum and it is important that graduates from these disciplines have a thorough understanding of the subject matter. A recent report compiled by the Department of Employment, Education and Training (DEET) highlighted the importance of data communications:

The convergence of communications and computing technology has long been heralded, but
continuing increases in cost effectiveness in both sectors have brought them to the point where widespread and rapid diffusion of networking technologies and applications is inevitable. This will lead to large and varied changes in the demand for skills, an effect which may be amplified in Australia’s case by the deregulation of the telecommunications sector. Such changes should be reflected by appropriate curriculum development (DEET, 1992, Vol 1, p 14).

Pilgrim and Leung (1993) previously examined the problems facing computing educators in teaching data communications finding that the rapid changes in communications technology have created many resource related and curriculum planning problems. They further found that data communications is perceived by both students and lecturing staff to be a difficult subject with its over use of acronyms, hardware related topics and wide range of complex and abstract concepts.

A common criticism of computer science courses such as data communications is that very few connections are made between the theory and practice. Traditional lectures usually provide information in encapsulated formats leaving it up to the students to establish the connections between the isolated facts and skills and the practical application of the aggregation of what is learnt. Some contemporary educationalists have suggested the theories of ‘anchored’ instruction or ‘situated’ learning (Reeves, 1992) where the process of constructing new knowledge is situated in meaningful and relevant contexts. These new theories maintain that learning should take place in real world environments that employ a context that make the learning more relevant. The Department of Employment, Education and Training (DEET) also acknowledge the importance of context by stating:

The emphasis in computing science courses ought to be less on the teaching of computing knowledge for its own sake, and more on teaching the design, development and application of systems in a practical context (DEET, 1992, Vol 1, p32).

Data Communications, like many subjects in computer science courses, should be taught in a similar way to engineering courses enabling students to understand the practical worth of the theoretical knowledge.

A final consideration relates to the problem of the rapid pace of technological change. It is impossible to predict what technology should be addressed in university courses, especially in rapidly growing areas such as data communications. Universities do attempt to create a completion orientated curriculum by speculating on future technological changes though the unpredictability of such change makes updating course content difficult. DEET believes that universities should instead address their approach to teaching and learning in relation to this problem:

Education and training needs in IT will evolve rapidly and there must be a strong emphasis on the generation of adaptable and flexible skills and on producing graduates who have the ability to learn new skills rapidly (DEET, 1992, Vol 1).

The importance of 'learning how to learn' cannot be over emphasised. Many graduates, as a result of traditional university approaches, believe that learning is only achieved through formal mechanisms and hence find it difficult to adapt to an ever changing work environment. Employers, when recruiting, no longer are primarily concerned with a graduates technical skills but rather their ability to learn new skills and to adapt to changing situations. Students must be given the opportunity to develop learning skills that will prepare them for a lifetime of learning within a world of rapid change.

It is within the context of these criticisms from students, industry and government that the MML data communications course has been designed.
The MML data communications course

The traditional university approach to teaching data communications involves a series of lectures covering the content along with a number of laboratories involving a set of practical exercises. The MML approach aims to:

- establish some connections between the theoretical lecture material and the practical world of data communications;
- provide an independent learning framework with effective feedback to allow students to develop learning skills;
- utilise multimedia technology to provide students with an effective learning experience to aid comprehension of the abstract and complex concepts in the course;

A range of approaches including the Internet, multimedia, computer managed learning and learning guides were used to achieve these aims.

Lectures

Lectures still continue to be of primary importance in the provision of critical experiences for students. Lectures within an MML structure are used to synthesise or pull together components of learning within an appropriate conceptual framework. Lectures must go beyond just a presentation of the content by providing motivation and the development of an appropriate attitudes to study and an understanding of the IT profession. The use of electronic lecture presentations, video clips and multimedia animations enhance the quality and effectiveness of the lecture series.

Electronic lecture presentations

Printed lecture notes (Leung, 1994) covering the entire data communications course have been developed over the past six years. These notes contain eight modules each beginning with a set clear objectives stating the objectives of each module. These lecture notes have recently been converted to electronic format to allow them to be projected using a portable LCD projector. The appropriate use of colour and slide builds have increased the effect of the presentations and the motivational value of the lecture series.

Video clips

One of the criticisms of the traditional approaches to teaching computer science courses is that there is little connection made between theory and real life practice (DEET, 1992). Data communications is very much a practical subject with a range of applications from computer networking to telecommunications systems. Many data communications lecturers often show physical props such as samples of cables and devices although the use of such props is generally limited to small lecture groups and physically small and disconnected devices.

The use of video to display examples of devices in their actual working conditions has been a powerful method of providing some practical examples. Video has often been difficult to manage as the serial nature of video inhibits on the flexibility required in a lecture presentation. The advent of digitised video which may be displayed by a computer provides full control over the sequencing of a lecture presentation by allowing the lecturer to determine if, when and how many times a video clip should be shown.
A number of QuickTime movie have been integrated into each module of the MML data communications lecture series. These video clips show examples of data communications equipment, devices, networks, cabling and even experts in their actual working environment. Each movie appear as an icon on an appropriate PowerPoint slide and may be launched by the use of the Windows Object Linking technique. The lecturer may choose to play the video clip at any time whilst the slide is being displayed. Pause, fast forward and reverse controls on the QuickTime interface provide full control to the lecturer. These movies provide a context in which a student can make appropriate connections between the theory and practice and therefore obtaining a deeper understanding of the subject area.

**Multimedia animations**

The use of dynamic animations can have profound effect on how learning occurs. Animations can excite and motivate and can allow learner to develop an understanding of complex and abstract concepts. Research suggests that visual analogies are a powerful mechanism for explaining complex systems by focusing attention and clarifying the context of verbal presentations. (Pilon et al, 1995) Graphics simplify complex illustrations by removing unnecessary detail and present abstract ideas more concretely through the analogical use of space, lines and arrows. (Milton, 1992) The mind uses symbols to represent, store and manipulate information therefore visual models may be used to stimulate recognition and memory. (Batten & Vander Velde, 1992; Kienegger-Domik, 1995) Hoogeveen (1995) has shown that when visual models are added to text, people pick up and understand a story faster than if they are confronted with a text only story and relates this theory to the experience of reading stories to young children who form connections with the displayed pictures more than the words of the story.

A series of multimedia animations have been created as an aid to explaining the large number of complex concepts that are in the data communications course. These animations were created using a range of tools including Authorware Professional and Multimedia Toolbook and typically consist of a short sequence of animated graphics to illustrate a concept. These animation files are also linked to an appropriate slide of the current PowerPoint presentation using the Object Linking technique appearing as an icon that may be selected during the lecture.

The use of these animations has been documented by Leung & Pilgrim (1995) who found that prior to the use of multimedia animations, the lecturer would attempt to explain concepts using a 2-dimensional, black and white diagram from the printed lecture notes. Although the diagram is generally supplemented by a page of textual information and a verbal explanation, students often find it difficult to grasp the meaning of concepts. To illustrate this point, Figure 1 shows an example of a diagram as presented in the lecture notes which describes the Continuous RQ Error Control Scheme. This scheme is a commonly used communications protocol to facilitate the transmission of data between the primary and secondary computers. The diagram shows how the data packets are exchanged when no transmission error takes place. Whilst the figure contains the essential information about the protocol, because of the inherent complexity, even with the support of textual explanation, the fundamental concept is not easy for the student to grasp.

A multimedia animation of the Continuous RQ concept has been created to clearly show the movement of packets of data between the systems and the full operation of the protocol. These graphical animations are particularly effective when explaining complex concepts to non-English speaking background students as they transcend the English language.
Future work

The electronic lecture notes along with the QuickTime movies and multimedia animations are currently being stored on a CD-ROM. A technique suggested by Pilgrim and Creek (1995) uses a software package called Lotus Screencam to quickly integrate PowerPoint presentations with an audio narrative. This technique, along with an appropriate interface, is being used to develop the CD-ROM as a self-paced learning tool. The final CD will contain a textual introduction to each of the modules and audio soundtracks explaining each of the slides, video clips and animations which may be fully controlled by the user. It is planned that this CD will be placed in the library so that students can review the lectures at their own pace.

Support for individual study

The use of a wide range of resources such as video, television, lectures, tutorials, audio tapes, books, etc. is not unique to the MML approach. Most universities encourage the use of a range of approaches. A multi-modal approach may be distinguished by its planned and structured selection of appropriate methods and media. Particular mediums of instruction are chosen to facilitate learning of particular parts or outcomes of a subject (Jeffery, 1993). There are a number of features of the MML data communications course which encourage individual study and by including timely and relevant feedback, these resources allow students to develop learning skills. These features include the use of learning guides and computer-managed learning.

Learning guides

Central to the MML concept is the Learning Guide. Learning Guides, as the name implies, guide the learner by documenting the plan for learning and the choice of resources to be used. These guides generally do not contain content, but rather present to the student a description of what has to be learnt, resources available for learning and how the student should demonstrate that learning has occurred.

Learning Guides also provide students the chance to take some responsibility for their own learning and in doing so encourage them to find out how they learn best. Skills needed to cope with new situations are developed to better prepare the student for a lifetime of learning in a changing world.

Computer-managed learning
The use of computers to assist in the assessment of the learner's understanding of educational material is called computer managed learning (CML). CML systems monitor and control a student's progress throughout a course. Features of CML systems may include: testing, tutorials, assessment tracking, progress tracking, reporting and feedback mechanisms.

Swinburne University of Technology has developed a CML system called ASSESS (Ciszewski & Murphy, 1992). This system supports testing, assessment tracking and reporting. A key feature of this system is that it provides the test result at the end of a test session along with a list of areas where the student did not perform well. This immediate feedback enables the student to find out if he or she has adequately grasped the material studied and allows the student to seek appropriate help.

Four CML tests are used during the data communications course providing constant and timely feedback to the student. The CML tests have proven popular with students who are unsure of their level of understanding of the concepts introduced during lectures. The feedback gained from the tests may be used by the students to adjust their approach to learning and assisting them in understanding more about how they best learn.

The Internet

The data communications course at Swinburne uses a variety of Internet services as tools to support the educational process. The Internet is not used directly as an instructional medium but as an efficient management and communication tool. The World Wide Web, listserv and email services are used in variety of ways. The use of IRC has also been trialed.

World Wide Web

The data communications subject has its own home page (http://edna.swin.edu.au/302356/sq407.html) which contains links to documents such as the syllabus, assessment details, assignment specifications, tutorial sheets and solutions, sample programming code and past exams. Very few graphics are used in these web pages in order to reduce response times. These web pages contain most of the handouts that are normally given out during the semester therefore saving a considerable amount of paper as well as distribution time. Students have responded positively to the open access to these documents rather than having to spend time getting copies from the library counter reserve. Part time students in particular have indicated that this system gives them the flexibility of being able to access documents from home.

Listserv discussion group

An electronic discussion group service has been set up specifically for the subject which provides an additional method for students to interact not only with lecturers and tutors, but also with other students. The system uses the LISTSERV features of the Internet. A LISTSERV is a mailing list program designed to copy and distribute electronic mail to everyone subscribed to the particular mailing list. LISTSERVs work on a concept called 'mail explosion'. An email message is sent by a subscriber to a central address (the LISTSERVs address) which 'explodes' the message by duplicating it and sending a copy of it to every subscriber. This 'mail explosion' concept allows the lecturer to communicate with all the students who have subscribed with just a single email letter sent to a central address. It also allows students to send a message to the whole student group.

This new discussion forum allows students to find answers to specific questions about the course material by emailing questions to the discussion group. All other students receive the question and are encouraged send answers back to the discussion group. The lecturers and tutors also participate in the resolution of the
questions. During the semester a variety of questions were discussed, some discussions lasting several days and involving a number of students and staff. Students, especially the part time postgraduate students, indicated that this provided them with a mechanism for opening up a debate on issues that could not be resolved in lectures.

Email

Traditional email is also encouraged, particularly as a tool of communication with the lecturer. Email is particularly important considering there are over 250 students who study data communications in the School of Computer Science and Software Engineering each year. Whilst questions about the content were directed to the discussion group, many personal queries were answered via email reducing the queue at the lecturers door.

IRC

Internet Relay Chat (IRC) is an Internet service that may be likened to a CB radio system. IRC provides users the ability to join channels and participate in live discussions with other users world wide using a textual interface. Once a channel has been joined, whatever a user types on their computer will be echoed to all other users who are currently on the channel. The interface provides a screen that scrolls up as the discussion proceeds. Discussions are usually social in nature and do provide an interesting experience for those participating.

In 1994, the MML working group experimented with the educational use of IRC. The MML project set up its own IRC server which was to be used for remote tutorials by allowing a tutor situated at the campus to communicate with a number of students who were working at their homes. Software known as WinIRC was used to allow the tutor to communicate either individually with a student or with the group as a whole. Each student had two windows on their screen, one displaying the group conversation and the other their own individual conversation with the tutor. The tutor had the group window as well as a window for each individual student. Students worked on a tutorial sheet which required them to show answers to the tutor at regular intervals. It was found that the tutor's screen could only manage up to six students before becoming too cluttered. Whilst the students found the experience satisfactory, the tutor found managing six simultaneous conversations difficult. Work on the establishment of suitable procedures for tutors and students to follow as well as an investigation into appropriate subject areas that suit IRC remote tutorials are now being examined.

Some observations

Whilst I am enthusiastic and positive about the introduction of new technology to education, I do have a number of concerns regarding the role that interactive multimedia and the Internet are expected to play.

Lately, the Internet has been regarded as the panacea of educational technology. For example, a press release by the Victorian Department of School Education (DSE) claims that "at a push of a button, more than 520,000 Victorian students and their 35,000 teachers will have the world's greatest knowledge and resource centres at their fingertips" (DSE, Herald Sun, Oct 17, 1995, p 40).

Unfortunately, the publicity and hype generated by the mass media has led to some unrealistic expectations. This statement by the DSE does not take into consideration the hardware and access costs associated with Internet. It makes no mention of the current problem of inadequate bandwidth on the current network. Adding half a million users to an already struggling backbone will result in frustration and disillusionment by users as response times increase. The Internet does provide some real benefits for education, but it is far from
the solution to cheap mass education as is claimed by some policy makers. New mechanisms for charging universities for Internet access has seen some departments considering reducing the level of student access. Strategies for increasing bandwidth within an affordable charging structure must be found if the Internet is going to make the impact on education that the public now expect.

Along with the Internet, interactive multimedia is also being promoted actively by those who believe it can provide students the ultimate learning environment. This is as much a misconception as the implication that teaching automatically results in learning. Learning is a complex process which cannot be readily simplified or understood. It is important to clarify that multimedia courseware does not and will never replace the role of the teacher/ lecturer in the educational process. This technology is just another tool that will assist in the process of learning in much the same way as a text book or a video might be used. With the current fervour, interactive multimedia is in danger of being used in software for purely cosmetic reasons rather than contributing to the educational effectiveness of such programs. As Clark (1990) reminds us, the contribution of media to the effectiveness of learning is no more than 'the truck which delivers groceries to the market contributes to the nutrition in a community.'

The instructional design process is the key to the educational effectiveness of any technology. The range of media, the innovative communications techniques and the appealing interfaces are important but secondary to the actual learning process. Romiszowski (1986) has highlighted the danger of ignoring the generic instructional design process and becoming too mesmerised by the 'bells and whistles' of the computer itself as a presentation medium. The key to the educational effectiveness of any course relates only to how well the student has achieved 'learning'. Both the Internet and interactive multimedia must be based on a strong theoretical and philosophical foundation in order to be effective.

References


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In the present study, multi-modal stimuli, including FL auditory word forms (Welsh), written native language translations (English), and pictures depicting the meaning of the words, were presented in a letter-search task to investigate the incidental acquisition of FL vocabulary. Exposure to FL auditory word forms on their own, in conjunction with written native language translations, or with both written native language translations and pictures was varied in a within-subject design. Participants' eye-movements were recorded during the incidental learning task in order to investigate the all.

Learning Analytics is the intelligent use of data generated from students with the objective of understanding and improving the teaching and learning process. We designed multimodal deep learning models to extract cross-market correlations by concatenating features at early, intermediate, and late fusions between modalities. The models place a different emphasis on intra and inter market correlations depending on the markets to be tested. International markets are a good case study for the effectiveness of deep learning in financial data fusion. Furthermore, modeling international markets is important in practice because investors and portfolio managers need to continually assess international information and adjust their portfolios accordingly, in order to take the benefits of portfolio diversification [30]. They are effective cases for studying the spillover effect because the trading time horizons of these markets do not overlap.